Allen-Bradley

Configurable Flowmeter Module

(1771-CFM/B)

User Manual

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is critical for successful application and understanding of the product.

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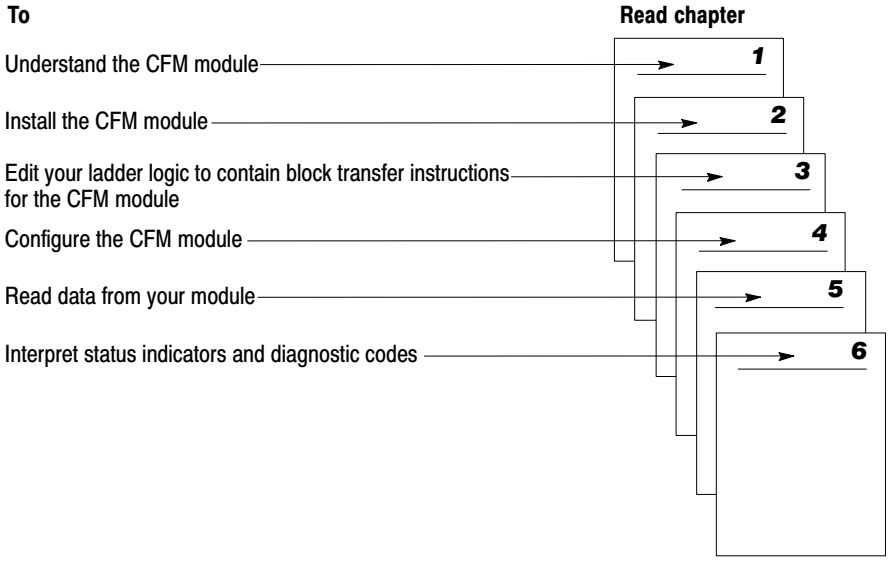
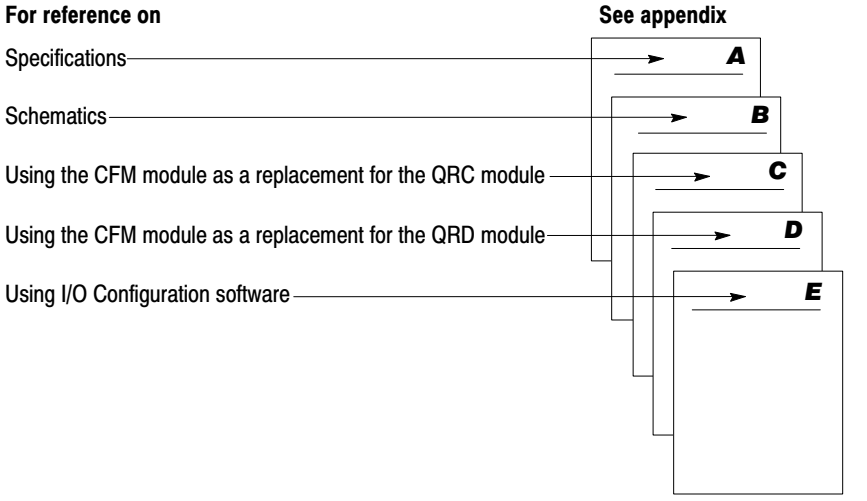
Using This Manual

What's In This Manual

Use this manual to install, program and troubleshoot your Configurable Flowmeter module (1771-CFM/B).

Important: We assume that you know how to program and operate an Allen-Bradley PLC® processor. If you do not, see the appropriate programming and operations manual for the PLC processor you are using, before you attempt to use this manual.





New/Updated Information

The1771-CFM/B is marked with the CE logo, indicating that this version complies with the European Union Directives. Technical additions and corrections are marked with change bars.

To comply with the European Union Directives, this information in the manual has been updated:

Updated information	On page(s)
European Union Directives compliance	2–2
CFM module field wiring arm connections	2–8
CFM module wiring examples	2–9
General specifications	A–1
CFM (QRC) module wiring arm connections	C–6
CFM (QRD) module wiring arm connections	D–6, D–7

Abbreviations

We refer to	As
Configurable Flowmeter module (1771-CFM/B)	CFM module
Configurable Flowmeter module emulating a 1771-QRC module	CFM (QRC) module
Configurable Flowmeter module emulating a 1771-QRD module	CFM (QRD) module
Allen-Bradley programmable logic controllers	PLC processors
1771-QRD Pulse Flowmeter module	QRD module
Bulletin 1771 Dual Ratemeter module (1771-QRC)	QRC module

Related Documentation

Document	Publication number
Configurable Flowmeter Module Product Data	1771-2.226
PLC-2® Programming Software Documentation Set (D6200-L06) *PLC-2 Programming Software Programming Manual*	6200-6.4.14
PLC-3® Programming Software Documentation Set (D6200-L07) *PLC-3 Programming Software Programming Manual*	6200-6.4.17
PLC-5® Programming Software Documentation Set (6200-N8.001) *PLC-5 Programming Software I/O Configuration Manual*	6200-6.4.12
PLC-5/250® Programming Software Documentation Set (6200-N8.002) *PLC-5/250 Programming Software Programming Manual*	5000-6.4.8
SCADA Custom Application Routines (CARs) for Gas and Liquid Petroleum Flow Calculations Product Profile	6200-1.22
PLC-5 Volume Flow CARs for Orifice Metering User Manual	6200-6.5.17
PLC-5 Volumetric Flow CARs for Turbine and Displacement Metering User Manual	6200-6.5.18

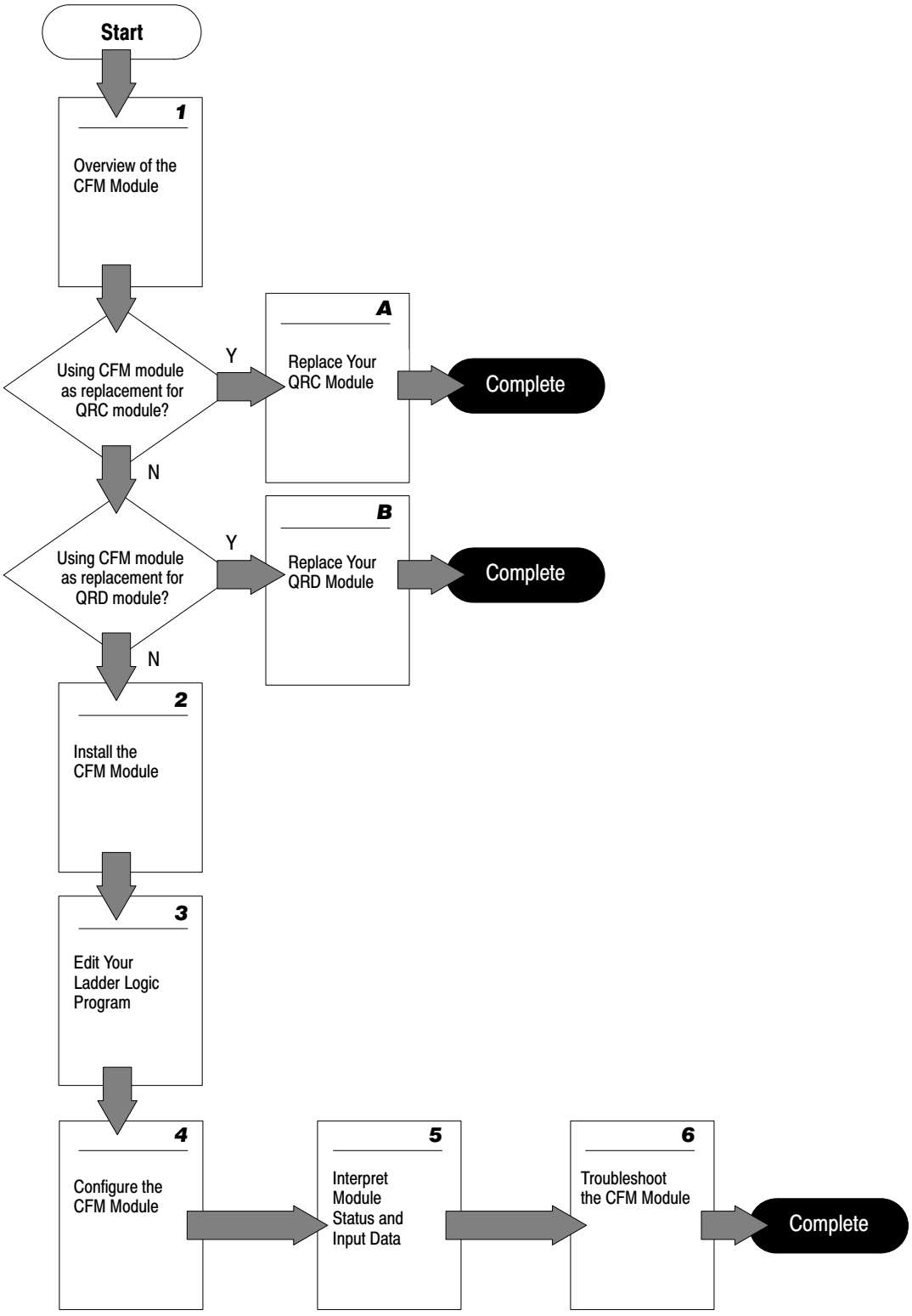
See the *Automation Group Publication Index* (publication SD499) for additional publications with information on PLC processors.

Related Products

You can install the CFM module in any system that uses PLC processors with block-transfer capability and the 1771 I/O structure. Contact your local Allen-Bradley representative for more information about our PLC processors.

Get Started

Use this diagram to help you get started.



Overview of the CFM Module

What This Chapter Contains

Read this chapter to familiarize yourself with the CFM module.

How You Use the CFM Module

The CFM module is designed to operate in one of three ways:

1 as a CFM module

- Make sure the module operation jumper is set in the CFM position.
- Wire input and outputs to swing arm (1771-WN).
- Install the CFM module.
- Edit your ladder logic to contain BTW and BTR instructions for the CFM module.
- Edit CFM module's BTW configuration block and send configuration BTW to the CFM module.

2 as a replacement for a QRC module

- Set the module operation jumper in the QRC position.
- Wire inputs to the new swing arm (1771-WN).
- Replace the QRC module with the CFM module.
- Continue to program BTRs as before (no changes to ladder logic).

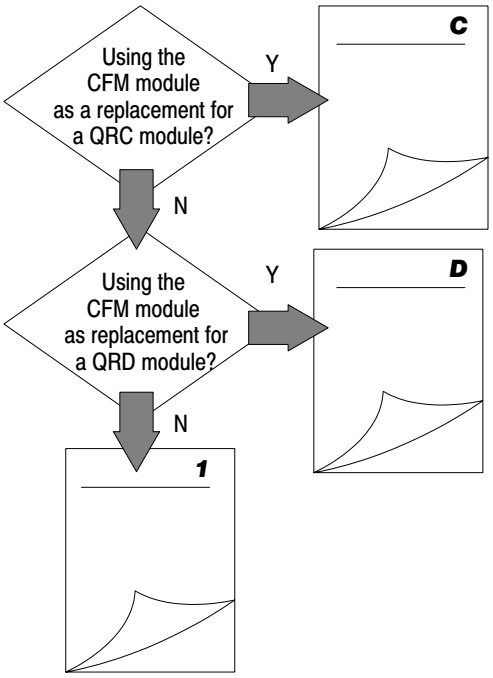
3 as a replacement for a QRD module

- Set the module operation jumper in the QRD position.
- Wire inputs to the new swing arm (1771-WN).
- Replace the QRD module with the CFM module.
- Continue to program BTWs and BTRs as before (no changes to ladder logic).

Important: If you use the CFM module as a replacement for a QRC or QRD module, the CFM module operates like a QRC or QRD module. You **do not** use any of the CFM module's features; therefore, you cannot configure outputs to any of the four input channels.

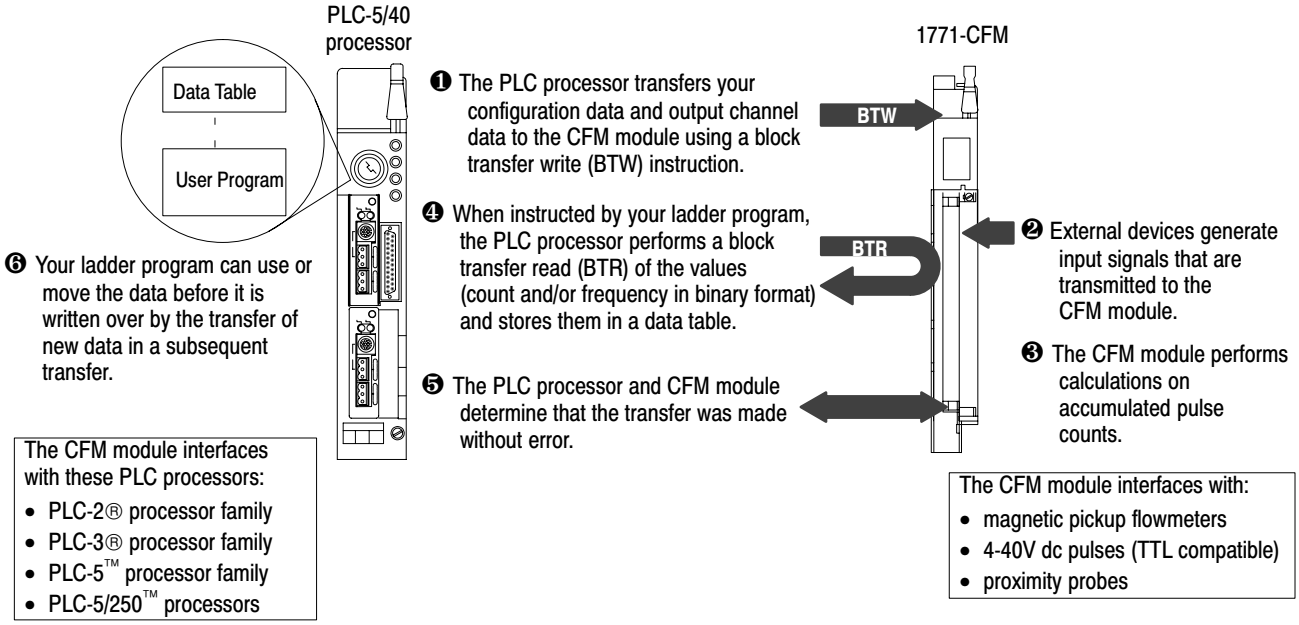
What's Next

The rest of this chapter contains information on CFM module operation.



What the CFM Module Does

The CFM module performs high-speed totalizing and/or rate calculation operations for various industrial applications. The CFM module is a single-slot I/O module that interfaces between an Allen-Bradley PLC processor that has block-transfer capability and external I/O devices.



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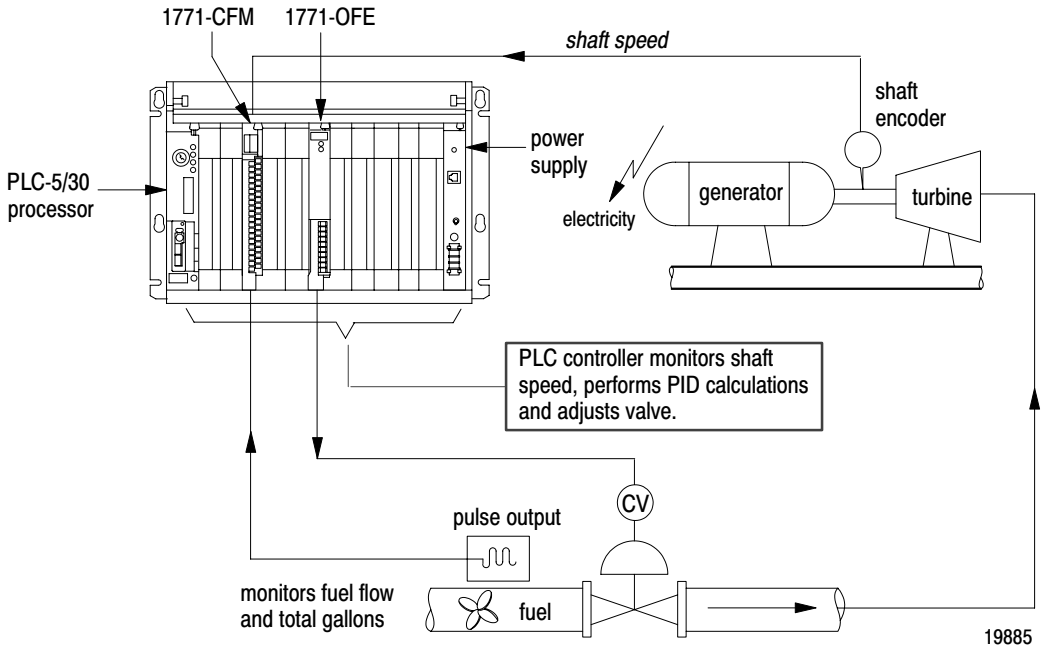
Typical Applications

You can use the CFM module in the power management, automotive, food and beverage, and oil and gas industries for various flow and/or turbine metering applications. Some sample applications include:

- turbine shaft speed monitoring
- automotive paint booths
- brewery flow monitoring
- petrochemical flow and custody transfer



Input Capabilities

The CFM module accepts input for up to four channels (mode dependent). Each of the four input channels may accept these input signals:

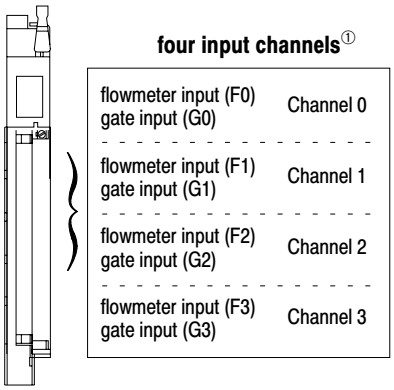
- magnetic pickup — 50mV to 200V ac peak (optional 500mV to 200V ac peak for improved noise immunity)
- 4-40V dc pulses with open collector (TTL compatible)
- proximity probe inputs
  - compatible with Bently Nevada 3300 (5mm and 8mm) proximity transducer systems
  - provides two isolated 24V dc power supplies (rated at 12mA) to power external devices

You configure the CFM module's four input channels for your specific application(s). Each input channel has two input selections:

flowmeter input (F0-F3) — you connect your input device to this input (ac, TTL)

gate input (G0-G3) — accepts 4-40V dc input pulse from open collector or external contact closure. Used in Totalizer and Nonresettable Totalizer modes to:

- store the current count of an input channel upon impulse on gate
- interface to a prover when a prover is enabled — used to store the count as the spheroid is sensed in the prover tube



① See pages 2–9 and 2–10 for wiring diagrams.

Selecting the Mode(s) of Operation

You configure the CFM module for these modes of operation:

Use this mode	To	Indicators/ Alarms	Prover	Total reset	Scaler values	Rollover value
Totalizer	• accurately measure counts using a flowmeter or positive displacement meter • trigger outputs directly from the CFM module — trigger on total, frequency, acceleration • monitor flow total, rate, and rate of change independent of your PLC processor scan times • store counts based on external input • scale the frequency and count to engineering units • interface to a prover	overrange overflow overspeed acceleration	√	√	√	√
Nonresettable Totalizer	operate in the Totalizer mode with the count reset function disabled to prevent loss of accumulated value	overrange overflow overspeed acceleration	√		√	√
High-resolution Frequency[1] (channels 0&1 or channels 2&3)	• monitor the frequency of an input with high accuracy (e.g. shaft) • monitor the rate of speed change • operate outputs based on speed or rate of change • scale the frequency to engineering units	overspeed overrange acceleration			√	
Direction Sensor[1] (channels 0&1 or channels 2&3)	• monitor the direction of shaft rotation • monitor rate of change and frequency • trigger outputs based on direction, frequency, rate of change • scale the frequency and count to engineering units	overspeed acceleration overrange			√	

[1] This mode uses two channels for one input (your input device is connected to F0 or F2, while F1 or F3 is unused).

Using a Prover

A prover is used for the calibration of liquid meters in custody transfer applications. This calibration is done by comparing a metered throughput to a known volume in the prover. The number of pulses accumulated (*Prover Total Count Value*), while the spheroid moves between two detectors, is then compared to the predetermined volume of the prover section to ascertain the meter factor.

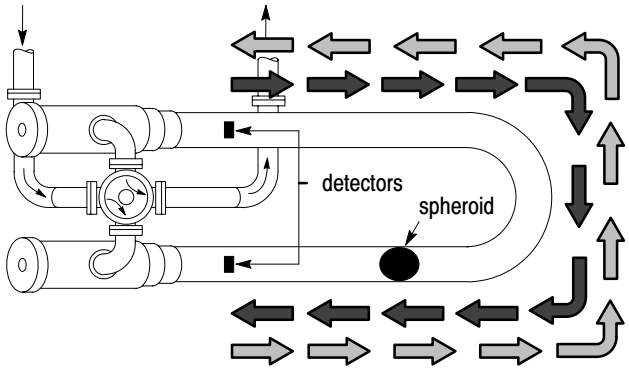
If you are using the Totalizer or Nonresettable Totalizer mode for capturing meter counts during a prover calibration, you have the option of selecting either of these types of provers:

unidirectional — the CFM module:

- begins counting when the spheroid passes the first detector
- stops counting when the spheroid passes the second detector (*Prover Total Count Value* is updated at this time)

bidirectional — the CFM module:

- begins counting when the spheroid passes the first detector
- stops counting when the spheroid passes the second detector (*Prover Total Count Value* is updated at this time – intermediate value returned)
- continues counting when the spheroid returns past the second detector
- stops counting when the spheroid returns past the first detector (*Prover Total Count Value* is updated at this time)



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Storing Current Count Values

If you are using the Totalizer or Nonresettable Totalizer mode and you are not using a prover, you can use the gate input to store the current count value of any (or all) of the four input channels.

The current count value of each channel is placed in a separate word in the BTR file (*Store Count Value)*. The *Store Count Value* will remain in the BTR file until a new trigger pulse is received at the gate input. The *Store Count Value* is then updated to reflect the new value.

Output Capabilities

The CFM module has four assignable outputs. These outputs are designed for applications that require fast response. The outputs:

- are electrically fused/current limited to 3A (output combinations are limited to 7A)
- can be assigned to any input channel with user-selectable turn-on and turn-off values
- are current sourcing at 5-40V dc (1A maximum per output)
- must be connected to an external power supply
- are in groups of two — this lets you use two separate external power supplies if desired (one for outputs 0&1 and one for outputs 2&3)

Outputs may be forced on or off independent of count or frequency value. They may be forced on and off by setting bits in the BTW configuration block.

Important: You can assign as many as four outputs to a given channel; however, you can not use the same output with two different channels.

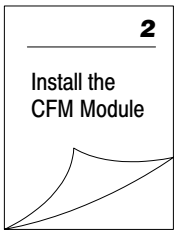
In this mode of operation	You can assign outputs that are programmable to trigger
Totalizer	on total, rate, rate change (acceleration), total overflow or prover status
Nonresettable Totalizer	on total, rate, rate change (acceleration), total overflow or prover status
High-resolution Frequency	on frequency or frequency rate of change (acceleration)
Direction Sensor	on either CLOCKWISE or COUNTER-CLOCKWISE direction, acceleration or frequency (outputs are triggered ON only)

Implementing Application Features

You can use the CFM module to implement programmable application features that are usually initiated by your PLC processor. This frees the PLC processor to do other tasks and helps increase the overall throughput of your PLC system.

This feature	Is used in these modes	To	Alarm is ON when
overflow indication	Totalizer Nonresettable Totalizer	set an overflow flag when the count is greater than the highest allowable count (programmable — rollover). This bit will toggle with each successive rollover (0-1-0-1-0-1). The count continues from zero. This bit can be reset in the BTW configuration block.	count = rollover (default 10,000,000)
overrange alarm	all	activate overrange alarm when rate is greater than allowable Hertz (fixed at 100kHz).	frequency > 100kHz
overspeed alarm	all	activate overspeed alarm when frequency is higher than user-specified frequency value.	frequency > user-specified value
acceleration alarm	all	activate acceleration alarm when acceleration is greater than user-specified acceleration value.	|acceleration| > user-specified value

What's Next



Install the CFM Module

What This Chapter Contains

Follow the instructions in this chapter to install the CFM module.

ATTENTION: Electrostatic discharge can damage integrated circuits or semiconductors if you touch backplane connector pins. Follow these guidelines when you handle the CFM module.

- Touch a grounded object to discharge static potential.
- Wear an approved wrist-strap grounding device.
- Do not touch the backplane connector or connector pins.
- Do not touch circuit components inside the module.
- If available, use a static-safe work station.
- When not in use, keep the CFM module in its static-shield bag.

Understand Compliance to European Union Directive

If this product has the CE mark it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2
  EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2
  EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131–2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information that this EN requires, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- *Industrial Automation Wiring and Grounding Guidelines* (for noise immunity), publication 1770-4.1
- *Guidelines for Handling Lithium Batteries*, publication AG-5.4
- *Automation Systems Catalog*, publication B111

Calculate Power Requirements

Your CFM module receives its power through the 1771 I/O chassis backplane from the chassis power supply. The maximum current drawn by the CFM module is **1.0A**.

Add this value to the requirements of all other modules in the I/O chassis to prevent overloading the chassis backplane and/or backplane power supply.

ATTENTION: When using a 1771-P7 or 1771-PS7 power supply to power an I/O chassis, you cannot place more than four CFM modules in this chassis.

The interaction between the four CFM modules and the 1771-P7 or 1771-PS7 power supply (not 16A limit) prevents the power supply from powering up.

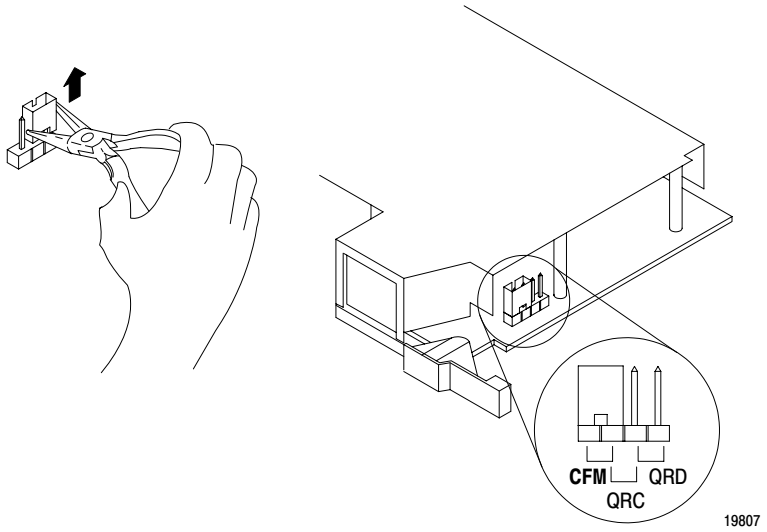
Set the Configuration Jumpers

You check or set these jumpers:

- module operation jumper
- input channel jumpers

Check the Module Operation Jumper

Important: Make sure the module operation jumper is in the **CFM** position (default setting).



If The Jumper Is Set In This Position	The CFM Module Will Operate As
QRC	a QRC module (no BTW / 3 word BTR)
QRD	a QRD module (1 word BTW / 9 word BTR)

Set the Input Channel Jumpers

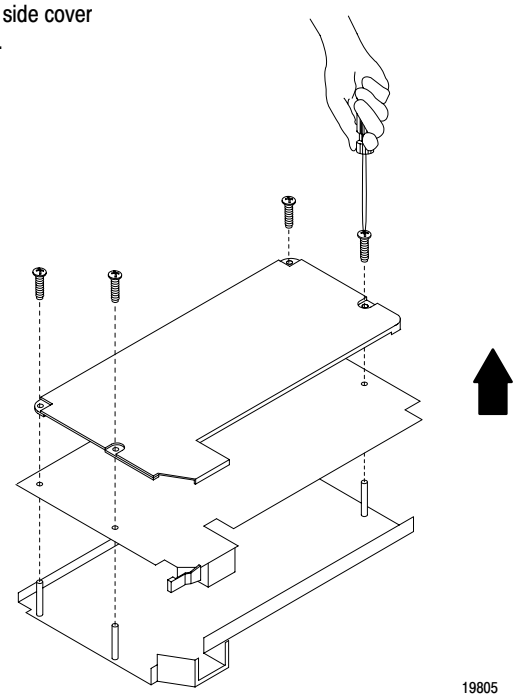
The CFM module has user-selectable jumpers for each flowmeter and gate input:

- flowmeter jumpers (F0-F3) — set jumper for low-pass filter (70Hz) or high-speed operation
- gate jumpers (G0-G3) — set jumper for +5-12V or +12-40V operation

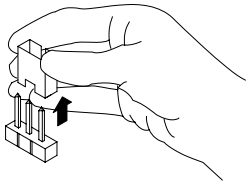
The CFM module is configured for high-speed operation. If any input channel will be accepting input from a mechanical switch, you need to set the flowmeter jumper for that input channel to filter operation. The filter provides debouncing for the mechanical switch.

ATTENTION: The frequency of counting must be less than 70Hz when the filter mode is selected. If the frequency exceeds 70Hz, the CFM module will not read the incoming pulse.

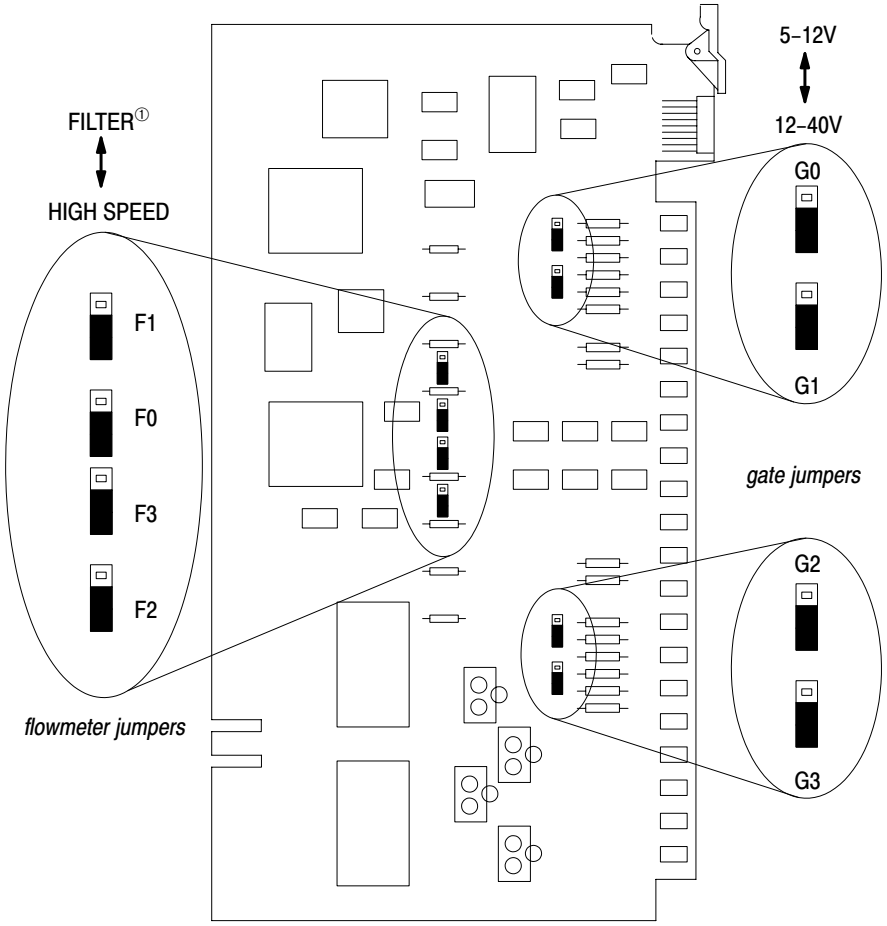
1 Remove the four screws securing the side cover to the module and remove the covers.



2 Reposition the flowmeter and gate jumpers associated with each input channel according to your requirements.



The flowmeter and gate jumpers② can be set independent of each other (you can select the filter action for each flowmeter input and a voltage for each and gate input independently).



① In the filter position, the module will not read frequencies above 70Hz.

② Jumpers are shown in default settings.

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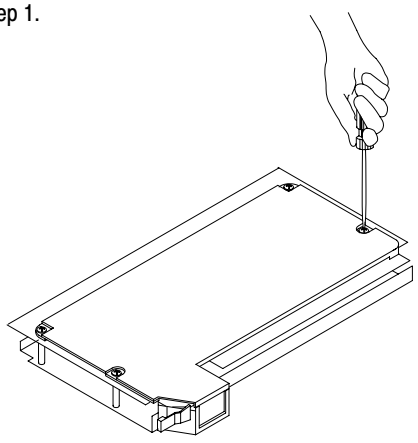
3 Reposition the cover and secure with the fours screws removed in step 1.



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Determine CFM Module Placement

Place your module in any slot of the I/O chassis except for the extreme left slot. This slot is reserved for processors or adapter modules.

Use of data table		2-slot addressing	1-slot addressing	1/2-slot addressing
Input Image Bits	8	Place the CFM module in any module group with any 8-bit or block transfer module.	Place the CFM module in any module group with any 8-bit, 16-bit or block transfer module.	no restrictions
Output Image Bits	8			
Read Block Words	41 max			
Write Block Words	60 max			

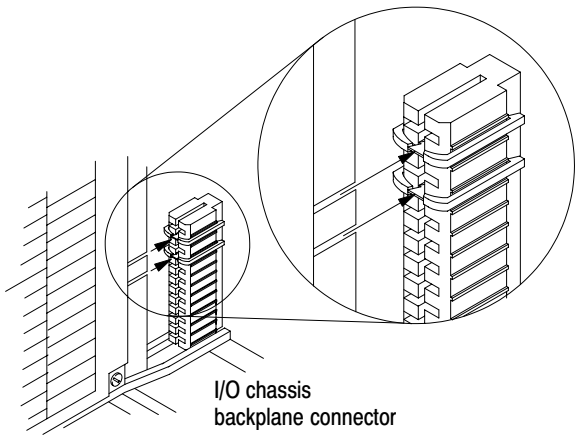
Key the Backplane Connector

ATTENTION: Observe the following precautions when inserting or removing keys:

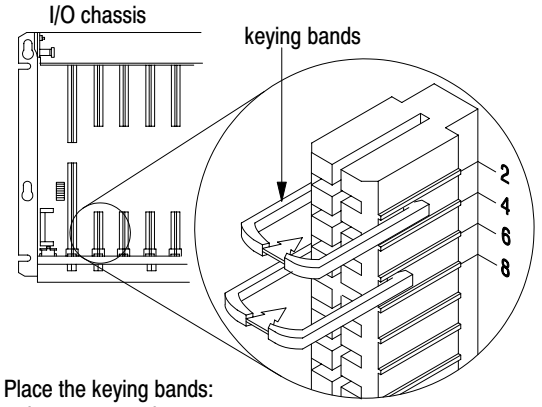
- insert or remove keys with your fingers
- make sure that key placement is correct

Incorrect keying or the use of a tool can result in damage to the backplane connector and possible system faults.

The CFM module is slotted in two places on the rear edge of the circuit board. These slots are intended to mate with the plastic keying bands supplied with the I/O chassis.



Position the keying bands in the backplane connectors to correspond to the key slots on the CFM module.



Place the keying bands:
between **2** and **4**
between **6** and **8**

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You can change the position of these bands if subsequent system design and rewiring makes insertion of a different type of module necessary.

Install the CFM Module

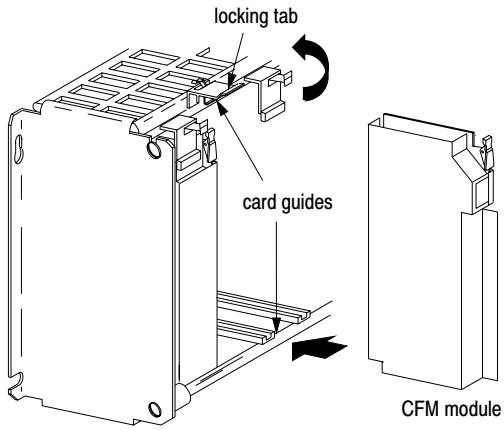
ATTENTION: Remove power from the 1771 I/O chassis backplane before you install the CFM module. Failure to remove power from the backplane could cause:

- injury
- equipment damage due to unexpected operation
- degradation of performance

1 Place the module in the card guides on the top and bottom of the slot that guide the CFM module into position.

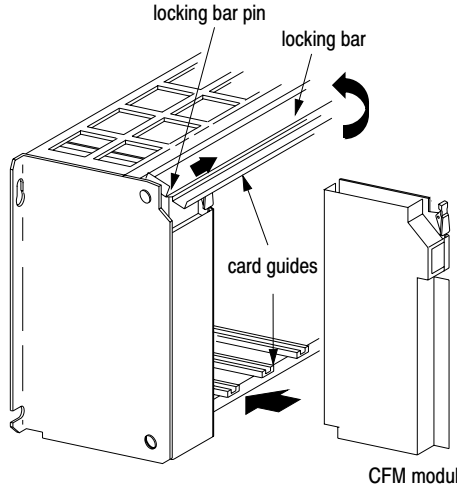
Important: Apply firm even pressure on the module to seat it into its backplane connector.

1771-A1B, -A2B, -A3B, -A3B1, -A4B I/O chassis



Snap the chassis latch over the top of the module to secure it.

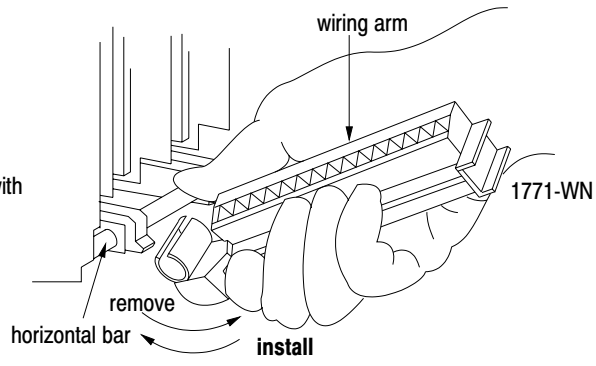
1771-A1B, -A2B, -A3B1, -A4B Series B I/O chassis



Swing the chassis locking bar down into place to secure the modules. Make sure the locking pins engage. 19809

2 Attach the wiring arm (1771-WN) to the horizontal bar at the bottom of the I/O chassis.

The wiring arm pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.



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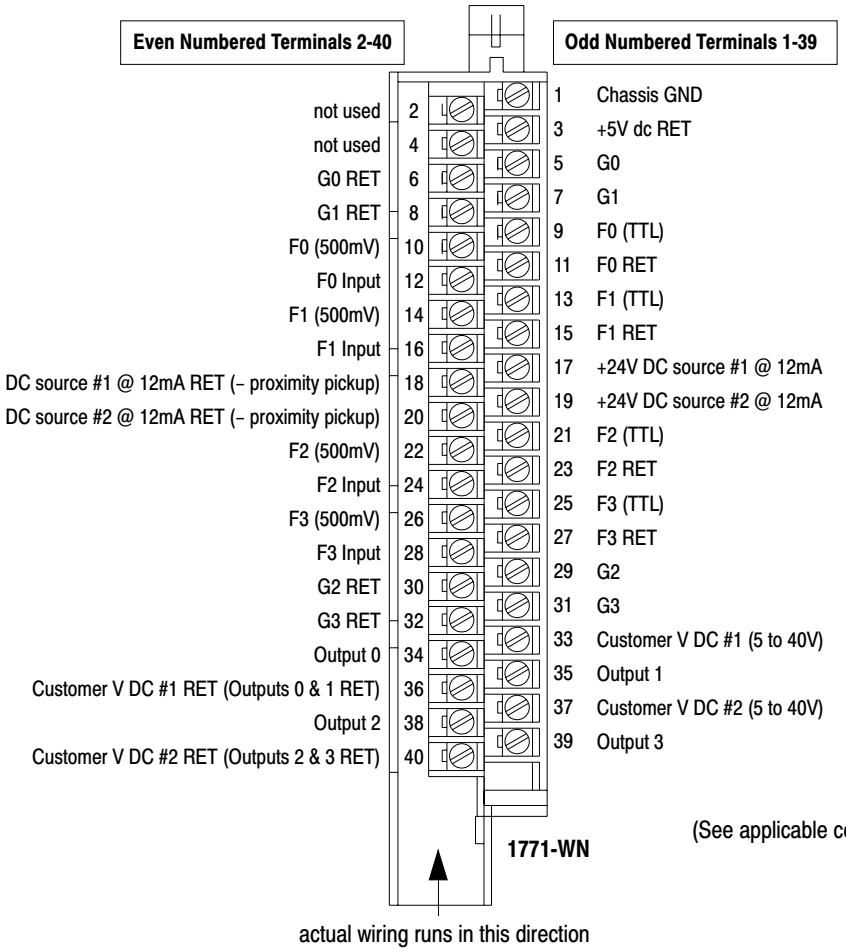
At power-up, the active and fault indicators are on. An initial module self-check occurs. If there is no fault, the fault indicator turns off. See page6–1 for information on interpreting the status indicators.

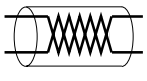
Make Connections to the Field Wiring Arm

Connect your I/O devices to the 40-terminal field wiring arm (cat. no. 1771-WN) shipped with the CFM module. Use the wiring examples on pages 2–9 and 2–10 for additional assistance on connecting your devices.

ATTENTION: Remove power to all I/O devices before you connect them to the wiring arm. Failure to remove power from your I/O devices could cause:

- injury
- damage to module circuitry
- equipment damage due to unexpected operation





The sensor cable must be shielded. The shield:

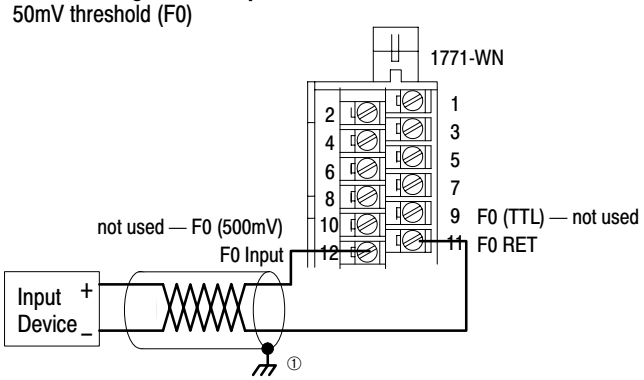
- must extend the length of the cable, but be connected only at the 1771 I/O chassis
- must extend up to the point of termination

Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

Wiring Examples

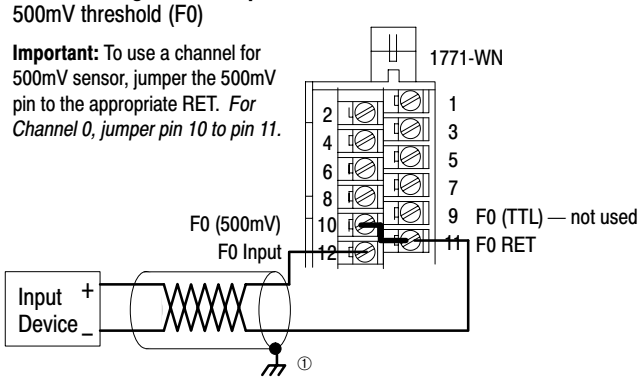
These wiring diagrams represent wiring for a flowmeter input (F0), a gate input (G0) and an output (O0). See the wiring arm diagram on page2–8 for the terminals used in wiring F1-F3, G1-G3 and O1-O3.

Standard Magnetic Pickup
50mV threshold (F0)



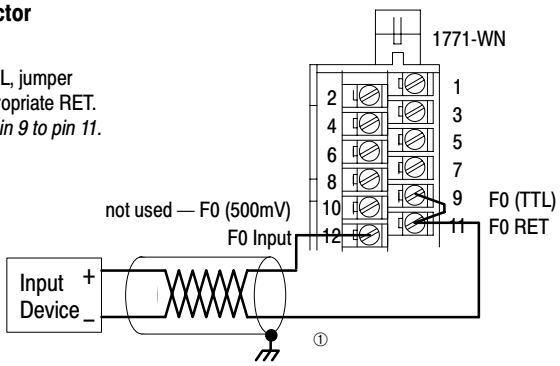
Standard Magnetic Pickup
500mV threshold (F0)

Important: To use a channel for 500mV sensor, jumper the 500mV pin to the appropriate RET. *For Channel 0, jumper pin 10 to pin 11.*

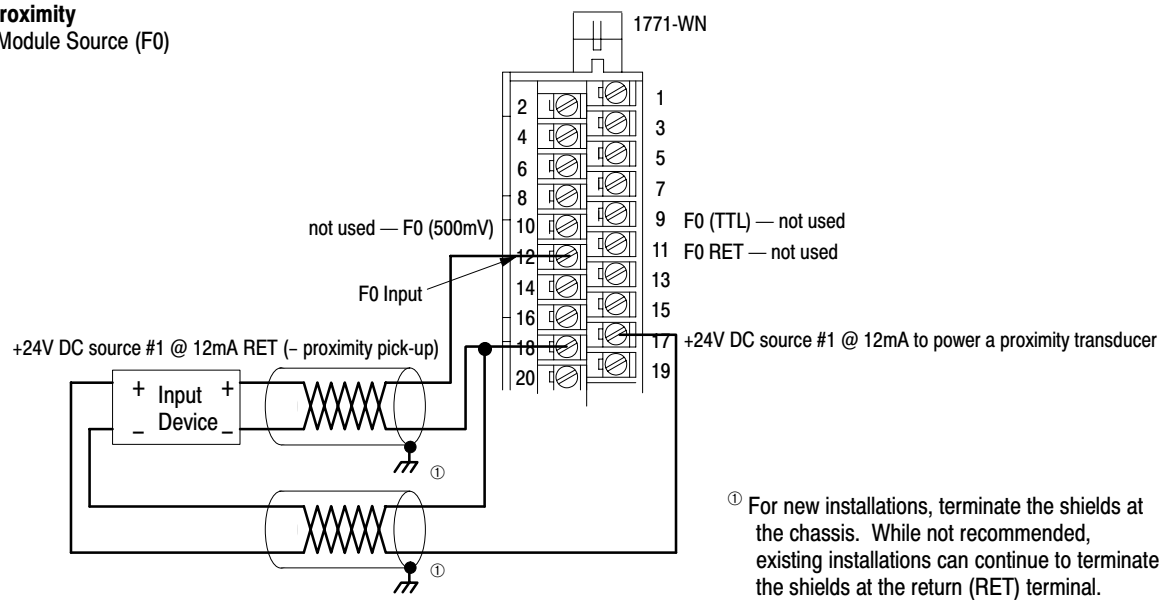


Standard TTL or Open Collector
1.3V threshold (F0)

Important: To use a channel in TTL, jumper the appropriate TTL pin to the appropriate RET. *To use Channel 0 in TTL, jumper pin 9 to pin 11.*

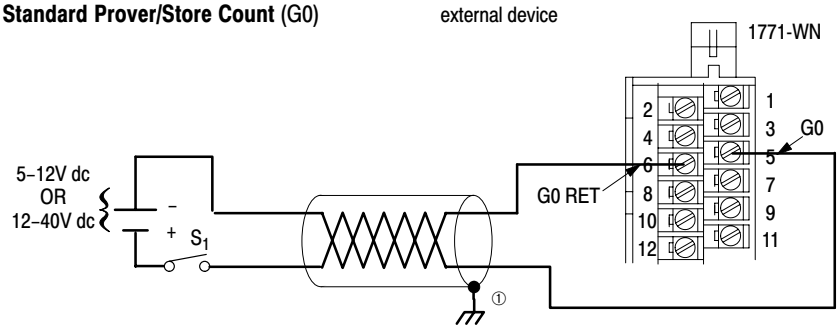


Standard Proximity
using CFM Module Source (F0)

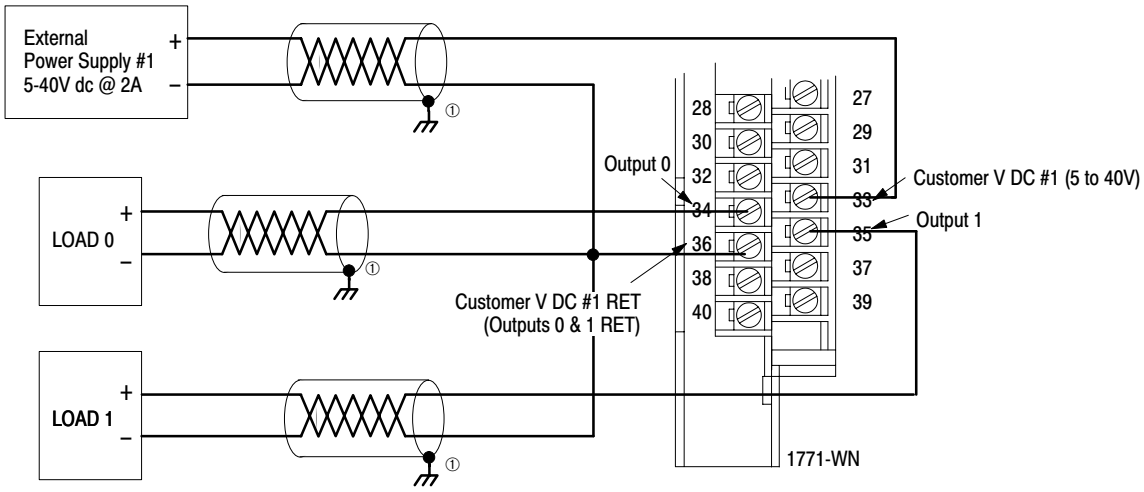


① For new installations, terminate the shields at the chassis. While not recommended, existing installations can continue to terminate the shields at the return (RET) terminal.

Standard Prover/Store Count (G0)

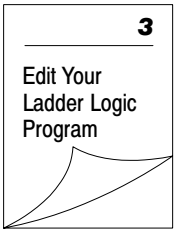


Standard Output (O0)



① For new installations, terminate the shields at the chassis. While not recommended, existing installations can continue to terminate the shields at the return (RET) terminal.

What's Next



Edit Your Ladder Logic Program

What This Chapter Contains

To initiate communication between the CFM module and your PLC processor, you must enter block transfer instructions into your ladder logic program. Use this chapter to enter the necessary block transfer instructions into your ladder logic program.

Enter Block Transfer Instructions

The CFM module communicates with the PLC processor through bidirectional block transfers. This is the sequential operation of both read and write block transfer instructions.

Before you configure the CFM module, you need to enter block transfer instructions into your ladder logic. The following example programs illustrate the minimum programming required for communication to take place between the CFM module and a PLC processor. These programs can be modified to suit your application requirements.

PLC-2 Family Processor

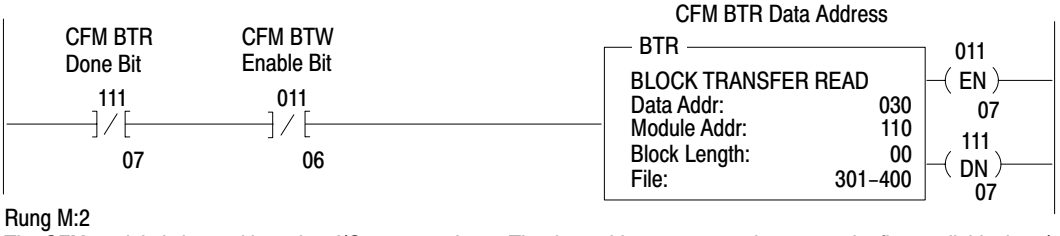
Important: The CFM module functions with reduced performance in PLC-2 systems. Because the CFM module does not support BCD and the PLC-2 processor is limited to values of 4095 (12 bit binary), many values returned in the BTR file may not provide meaningful data to the PLC-2 processor.

Use the following rungs to establish communication between the CFM module and a PLC-2 processor.

PLC-2 Processor Program Example

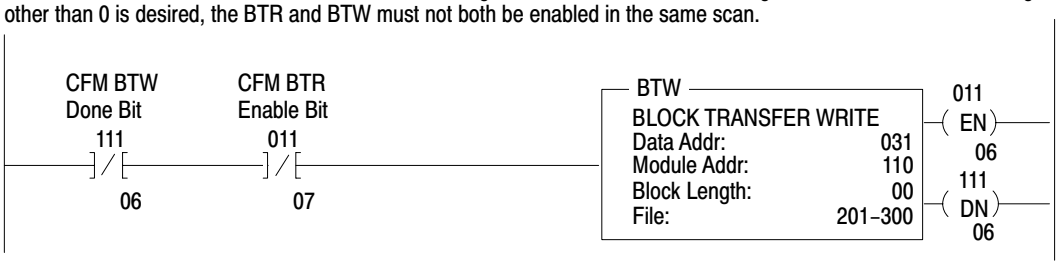
Rung M:1

The CFM module is located in rack 1, I/O group 1, slot 0. The data address 030 must be among the first available timer/counter address used for block transfer. The default block length of 0 will return 41 words starting at address 301. If a block length other than 0 is desired, the BTR and BTW must not both be enabled in the same scan.



Rung M:2

The CFM module is located in rack 1, I/O group 1, slot 0. The data address 031 must be among the first available timer/counter address used for block transfer. The default length of 0 will send 60 words starting at address 201. If a block length other than 0 is desired, the BTR and BTW must not both be enabled in the same scan.

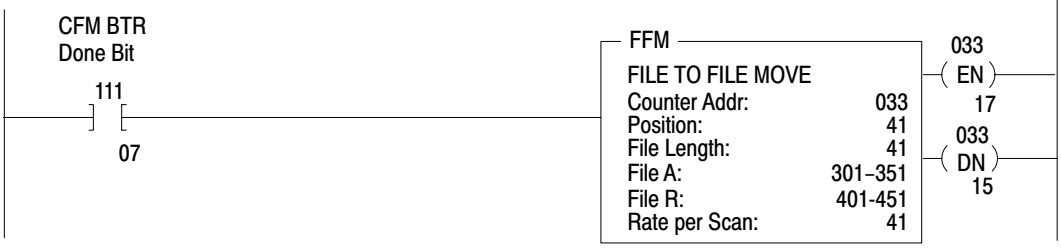


Rung M:3

This rung is used to place a zero between the first available timer counters used for all block transfers and those used throughout the rest of the program.

Rung M:4

This rung uses the BTR done bit to trigger a FFM that moves the CFM status to a buffered data file. The program should access all CFM data from the file starting at 401.



PLC-3 Family Processor

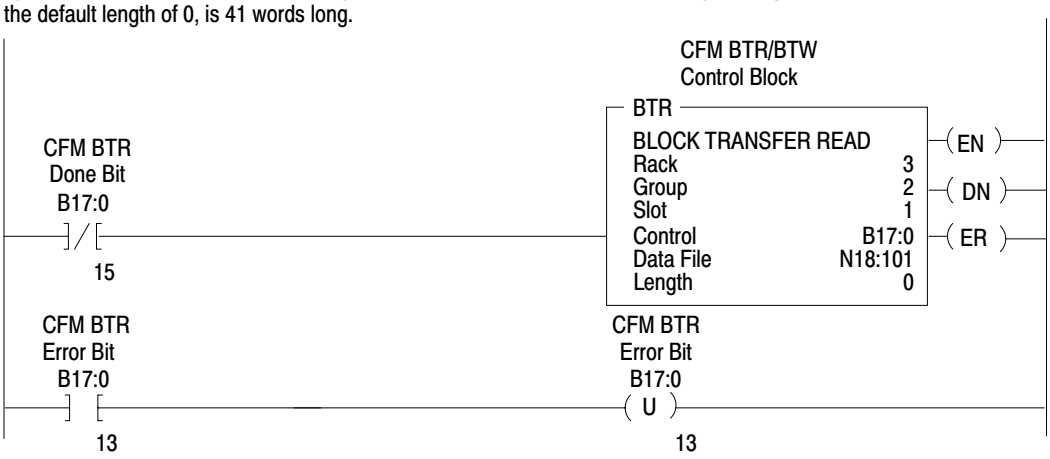
Block transfer instructions with the PLC-3 processor use a control file and a data file. The block transfer control file contains the data table section for module location, the address of the block transfer data file and other related data. The block transfer data file stores data that you want transferred to the module (when programming a BTW) or from the module (when programming a BTR).

The programming terminal prompts you to create a control file when a block transfer instruction is being programmed. **The same block transfer control file is used for both the read and write instructions for your module.** A different block transfer control file is required for every module.

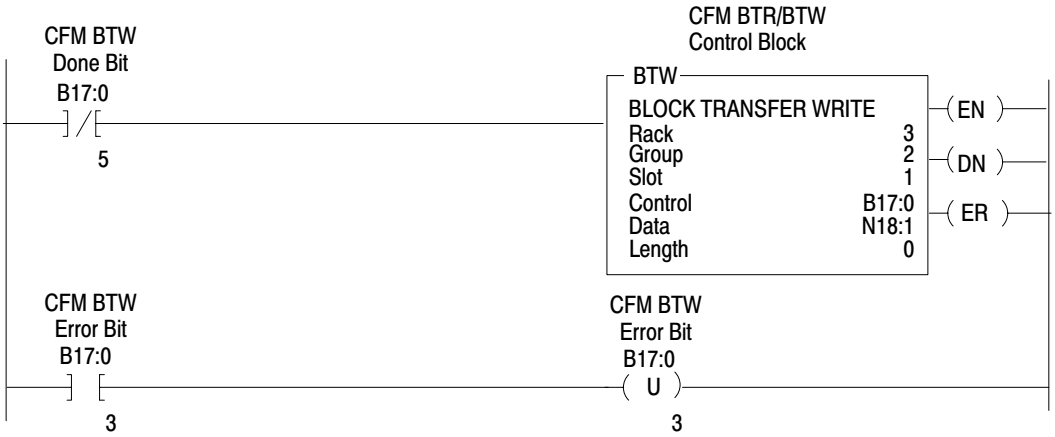
PLC-3 Processor Program Example

Rung M:0

The CFM module is located in rack 3, I/O group 2, slot 1. The control file is a 10 word file starting at B17:0 that is shared by the BTR/BTW. The data obtained by the PLC3 processor is placed in memory starting at location N18:101, and with the default length of 0, is 41 words long.



The CFM module is located in rack 3, I/O group 2, slot 1. The control file is a 10 word file starting at B17:0 that is shared by the BTR/BTW. The data sent by the PLC-3 processor to the CFM module is from PLC memory starting at N18:1, and with the default length of 0, is 60 words long.



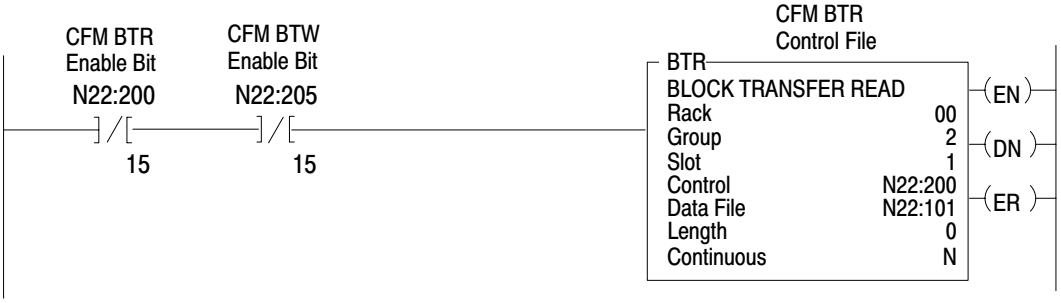
PLC-5 Family Processor

Block transfer instructions with the PLC-5 processor use a control file and a data file. The block transfer control file contains the data table section for module location, the address of the block transfer data file and other related data. The block transfer data file stores data that you want transferred to the module (when programming a BTW) or from the module (when programming a BTR).

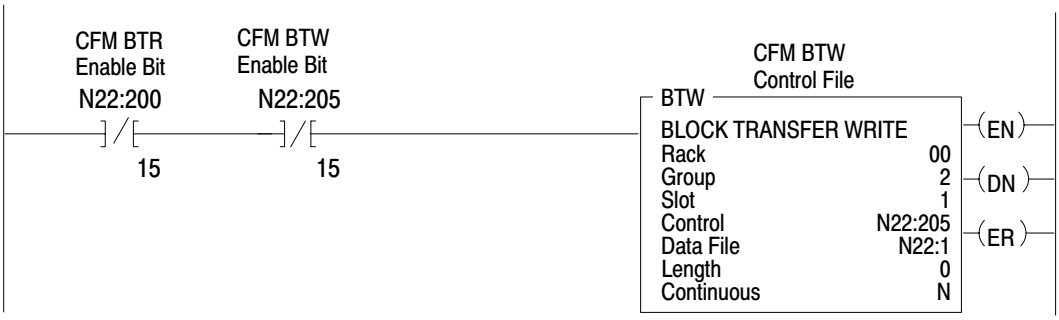
The programming terminal prompts you to create a control file when a block transfer instruction is being programmed. **A different block transfer control file is used for the read and write instructions for your module.**

PLC-5 Processor Program Example

Rung 2:0
The CFM module is located in rack 0, I/O group 2, slot 1. The integer control file starts at N22:200, is 5 words long and is compatible with all PLC-5 family members. The data obtained by the PLC-5 processor from the CFM module is placed in memory starting at N22:101, and with the default length of 0, is 41 words long. The length can be any number between 0 and 41. In enhanced PLC-5 processors①, the block transfer data type may be used as a control file.



Rung 2:1
The CFM module is located in rack 0, group 2, slot 1. The integer control file starts at N22:205, is a 5 words long and is compatible will all PLC-5 family members. The data sent by the PLC-5 processor to the CFM module starts at N22:1, and with the default length of 0, is 60 words long. Valid BTW lengths: 0, 1, 2, 3, 4, 14, 24, 34, 44, 48, 52, 56 and 60.
In enhanced PLC-5 processors[1], the block transfer data type may be used as a control file.



① Enhanced PLC-5 processors include: PLC-5/11, -5/20, -5/3*x*, -5/4*x*, and -5/6*x*.

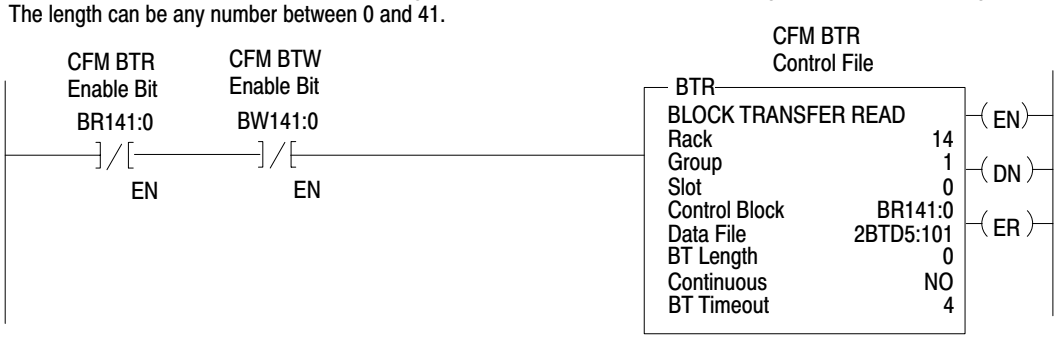
PLC-5/250 Processor

Block transfer instructions with the PLC-5/250 processor use a control file and a data file. The block transfer control file contains the data table section for module location, the address of the block transfer data file and other related data. The block transfer data file stores data that you want transferred to the module (when programming a BTW) or from the module (when programming a BTR).

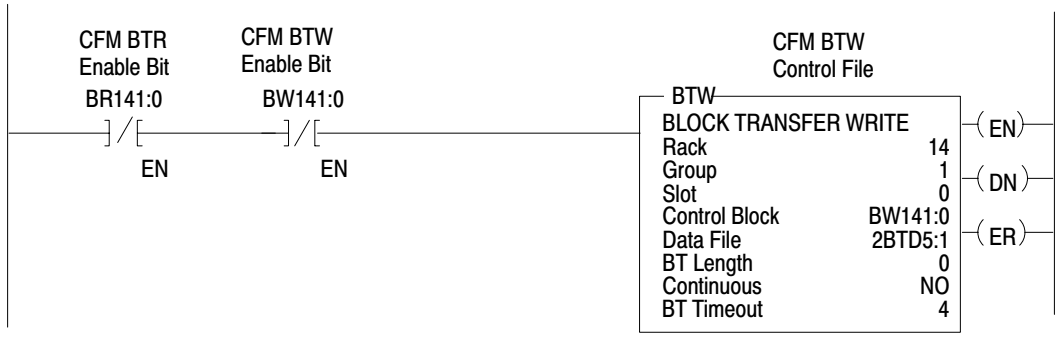
The programming terminal will automatically select the control file based on rack, group and module, and whether it is a read or write. **A different block transfer control file is used for the read and write instructions for your module.** A different block transfer control file is required for every module.

PLC-5/250 Processor Program Example

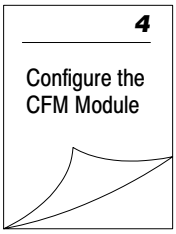
Rung 1STEPO:1
The CFM module is located in rack 14, I/O group 1, slot 0. The data obtained by the PLC-5/250 processor from the CFM module is placed in the data table starting at 2BTD5:101, and with the default length of 0, is 41 words long. The length can be any number between 0 and 41.



Rung 1STEPO:1
The CFM module is located in rack 14, I/O group 1, slot 0. The data sent to the CFM module from the PLC-5/250 processor is from the data table starting at 2BTD5:1, and with a default length of 0, is 60 words long.
Valid BTW lengths: 0, 1, 2, 3, 4, 14, 24, 34, 44, 48, 52, 56 and 60.



What's Next



Configure the CFM Module

What This Chapter Contains

Use this chapter to configure the CFM module.

Important: You must edit your ladder logic as shown in chapter 3 before you can use this chapter to configure the BTW configuration block.

Understand the CFM Module's BTW Structure

Data is conditioned through a group of data table words that are transferred from the PLC processor to the CFM module using a BTW instruction. Now that you have entered BTW and BTR instructions into your ladder logic, you are ready to enter data into the BTW instruction. This data should conform to the input device and specific application that you have chosen.

During normal operation, the processor transfers from 1 to 60 words to the CFM module when you program a BTW instruction to the CFM module's address.

Important: You must program at least one BTW, with a word length of 4, to get useful data back from the CFM module.

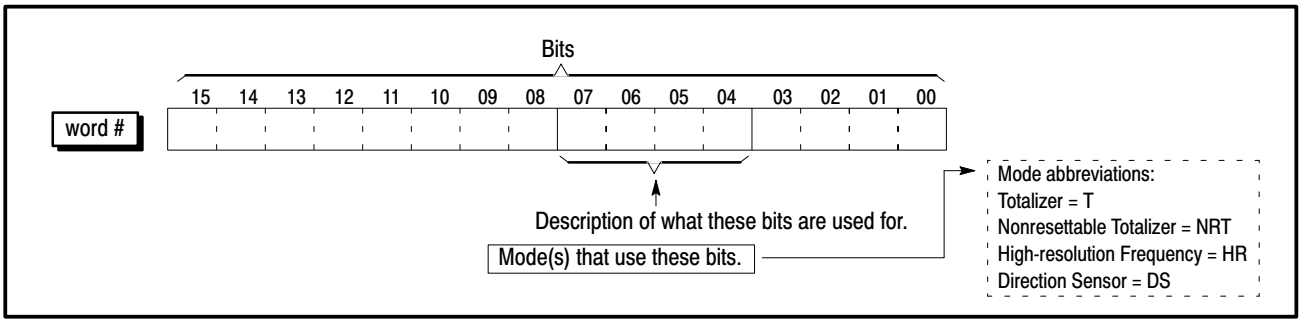
For	See page(s)
a general overview of the CFM module's BTW configuration block	4–2
detailed descriptions of each word in the BTW configuration block	4–3 through 4–7

BTW Configuration Block

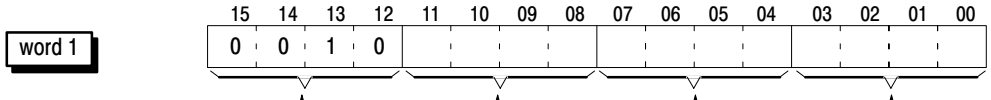
Word(s)[1]	Bit[2] 15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Block ID & Resets																
1	Header				Prover Run Initialize				Overflow Reset				Total Reset			
Output 1 and Output 0 Trigger & Select																
2	Output 1 Trigger				Tie Output 1 to Channel				Output 0 Trigger				Tie Output 0 to Channel			
Output 3 and Output 2 Trigger & Select																
3	Output 3 Trigger				Tie Output 3 to Channel				Output 2 Trigger				Tie Output 2 to Channel			
Input Channel Operating Mode																
4	Channel 3				Channel 2				Channel 1				Channel 0			
Input Channel Configuration	**Channel 0 (words 5-14)**				**Channel 1 (words 15-24)**				**Channel 2 (words 25-34)**				**Channel 3 (words 35-44)**			
5, 15, 25, 35	Frequency in 10ths	Bandwidth Limit	Sampling Termination	4 x High Hz	Prover Type	Debounce Filtering	Acceleration Calculation Time									
6, 16, 26, 36	Minimum Frequency Sampling Time															
7, 17, 27, 37	Number of Pulses to Terminate Sampling															
8, 18, 28, 38	Highest Allowable Frequency															
9, 19, 29, 39	Acceleration Alarm Value (what rate to trigger on)															
10, 20, 30, 40	Frequency Scaler Multiplier[3]								Frequency Scaler Divisor[3]							
11, 21, 31, 41	Total Scaler Multiplier[3]															
12, 22, 32, 42	Total Scaler Divisor[3]															
13, 23, 33, 43	Rollover Value — Most Significant Digit (0-999 x 10,000)															
14, 24, 34, 44	Rollover Value — Least Significant Digit (0-9,999)															
Output Configuration	**Output 0 (words 45-48)**				**Output 1 (words 49-52)**				**Output 2 (words 53-56)**				**Output 3 (words 57-60)**			
45, 49, 53, 57	Output ON value — Most Significant Digit (0-999 x 10,000)															
46, 50, 54, 58	Output ON value — Least Significant Digit (0-9,999)															
47, 51, 55, 59	Output OFF value — Most Significant Digit (0-999 x 10,000)															
48, 52, 56, 60	Output OFF value — Least Significant Digit (0-9,999)															

[1] Valid BTW lengths are: 0, 1, 2, 3, 4, 14, 24, 34, 44, 48, 52, 56, 60.
[2] ALL numeric values are in binary.
[3] When scaling is used, all outputs are still controlled by the actual value not the scaled value.

BTW Word Description Key



BTW Word Descriptions



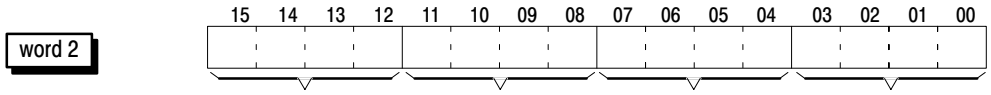
Header must be 0010. Identifies the module as a CFM module.

Prover Run Initialize initializes the channel for prover inputs on the Gate. Also resets *Store Count Value* (BTR words 13 & 14). Only occurs on a change in bit state from a 0 to a 1. This bit should remain ON (= 1) until the prover is done or until the prover run is aborted.
b08 = Counter 0 b10 = Counter 2
b09 = Counter 1 b11 = Counter 3

If this bit is OFF (= 0), a low to high transition of the Gate will store the current count in *Store Count Value* (BTR words 13 & 14).
T, NRT

Overflow Reset resets the overflow status of the module for the appropriate counter on a 0 to 1 transition. Only occurs on a change in bit state from a 0 to a 1.
b04 = Counter 0 b06 = Counter 2
b05 = Counter 1 b07 = Counter 3
T, NRT

Total Reset resets the total count for the appropriate counter on a 0 to 1 transition. Only occurs on a change in bit state from a 0 to a 1.
b00 = Counter 0
b01 = Counter 1
b02 = Counter 2
b03 = Counter 3
T

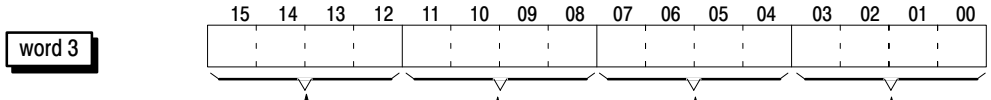


Output 1 Trigger selects what channel characteristic output 1 is triggered ON or OFF by placing the shown hex values in these bits:
0 = Force OFF, 1 = Frequency — all
2 = % of Fullscale Frequency — T, NRT, HR
3 = Acceleration — all
4 = Total Value — T, NRT
5 = Direction — DS
6 = Overflow, 7 = Prover Running, 8 = Prover Range — T, NRT
F = Force ON — all

Tie Output 1 to Channel ties output 1 to operate according to the state of a specific channel.
b08 = Counter 0 b10 = Counter 2
b09 = Counter 1 b11 = Counter 3

Output 0 Trigger selects what channel characteristic output 0 is triggered ON or OFF by placing the shown hex values in these bits:
0 = Force OFF, 1 = Frequency — all
2 = % of Fullscale Frequency — T, NRT, HR
3 = Acceleration — all
4 = Total Value — T, NRT
5 = Direction — DS
6 = Overflow, 7 = Prover Running, 8 = Prover Range — T, NRT
F = Force ON — all

Tie Output 0 to Channel ties output 0 to operate according to the state of a specific channel.
b00 = Counter 0
b01 = Counter 1
b02 = Counter 2
b03 = Counter 3



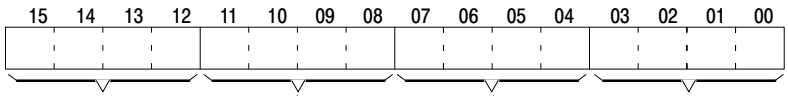
Output 3 Trigger selects what channel characteristic output 3 is triggered ON or OFF by placing the shown hex values in these bits:
0 = Force OFF, 1 = Frequency — all
2 = % of Fullscale Frequency — T, NRT, HR
3 = Acceleration — all
4 = Total Value — T, NRT
5 = Direction — DS
6 = Overflow, 7 = Prover Running, 8 = Prover Range — T, NRT
F = Force ON — all

Tie Output 3 to Channel ties output 3 to operate according to the state of a specific channel.
b08 = Counter 0 b10 = Counter 2
b09 = Counter 1 b11 = Counter 3

Output 2 Trigger selects what channel characteristic output 2 is triggered ON or OFF by placing the shown hex values in these bits:
0 = Force OFF, 1 = Frequency — all
2 = % of Fullscale Frequency — T, NRT, HR
3 = Acceleration — all
4 = Total Value — T, NRT
5 = Direction — DS
6 = Overflow, 7 = Prover Running, 8 = Prover Range — T, NRT
F = Force ON — all

Tie Output 2 to Channel ties output 2 to operate according to the state of a specific channel.
b00 = Counter 0
b01 = Counter 1
b02 = Counter 2
b03 = Counter 3

word 4



Operating Mode for Channel 3 **Operating Mode for Channel 2** **Operating Mode for Channel 1** **Operating Mode for Channel 0**

Select a mode of operation on a per channel basis by placing the shown hex values in the proper bits:

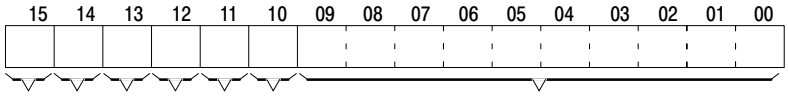
0 = unused channel
1 = Totalizer
2 = Nonresettable Totalizer
3 = High-resolution Frequency (channels 0 & 1 or 2 & 3)①
4 = Direction Sensor (channels 0 & 1 or 2 & 3)①②

① These modes are selected only via channel 0 or channel 2.

② If using both channels (0 & 1 and 2 & 3) for this mode, you cannot set sampling time for both = 4ms.

---

word 5 (channel 0)
word 15 (channel 1)
word 25 (channel 2)
word 35 (channel 3)



Frequency in 10ths allows you to select the precision of the frequency returned in the BTR. If set, the frequency is returned with the LSD being in tenths, while if 0, the LSD is in ones.
0 = frequency returned as 100, 123
1 = frequency returned as 100, 123.2
HR

Sampling Termination if set, enables the input sampling to be terminated on either a time base only (BTW 6) *or* a set number of input pulses (BTW 7) depending on which condition arises first.
HR

Debounce Filtering debounces the Gate input for a period of 1s. The first low to high transition of the gate will cause the CFM module to take appropriate action (no other transitions will be seen for 1s).
0 = OFF / 1 = ON
T, NRT

Acceleration Calculation Time calculates acceleration every Nth frequency sample.
0 = acceleration rolling average over 5 samples
1-750 = number of frequency samples (BTW 9 *Acceleration Alarm Value* must ≠ 0).

For example, if you place a value of 7 here, the CFM module:

a. stores the 1st frequency calculation
b. subtracts this calculation from the 8th frequency sample
c. divides this remainder by the time between samples and places the result in BTR 11, 20, 29 or 38
d. stores the 8th frequency sample and waits for the 15th sample

all

Bandwidth Limit if set, limits the minimum frequency the CFM module is capable of reading to 1/*Minimum Frequency Sampling Time*. When 1: the worst case response time of the module is decreased to approximately 2 x *Minimum Frequency Sampling Time*. When 0: frequency range = 1Hz - 100kHz (worst case response time can be 2s at extremely low frequencies)
0 = full frequency range (1Hz - 100kHz)
1 = minimum frequency (1/*Minimum Frequency Sampling Time*)
all

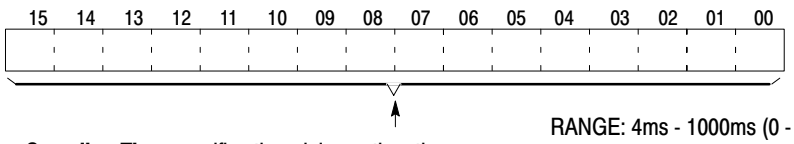
Prover Type selects the type of prover being used (unidirectional or bidirectional):
0 = unidirectional (1 run, 2 switches)
1 = bidirectional (4 switch run)
T, NRT

4 x High Hertz if set, the *Highest Allowable Frequency* entry is multiplied by 4 to enable entries > 32,767.

For example, to get a 100,000 peak allowable frequency, you set this bit and enter 25,000 in the word containing the *Highest Allowable Frequency* (BTW 8, 18, 28 or 38).
all

---

word 6 (channel 0)
word 16 (channel 1)
word 26 (channel 2)
word 36 (channel 3)



Minimum Frequency Sampling Time specifies the minimum time the CFM module spends to determine frequency (unless *Number of Pulses to Terminate Sampling* is enabled in High-resolution Frequency mode, which may allow the the input channel to end sampling earlier than the specified minimum).

Important: In Direction Sensor, this time is used to determine the maximum sample time and the minimum frequency returned and does not actually determine the time period for frequency sampling.

all

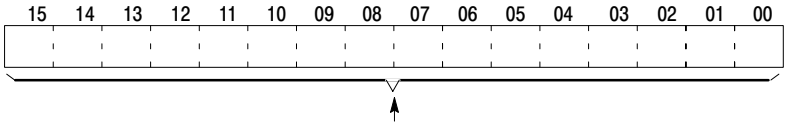
RANGE: 4ms - 1000ms (0 - 3 = DEFAULT)
DEFAULTS: HR, DS = 4ms / T, NRT = 100ms

The maximum sampling time is:

< 2s — if the *Bandwidth Limit* is not enabled and a signal < 1 Hz is applied (sample time ≈ *Minimum Frequency Sampling Time* + 1/frequency input)

< 2 x the *Minimum Frequency Sampling Time* — if *Bandwidth Limit* is enabled and a very low input signal frequency is applied (sample time ≈ *Minimum Frequency Sampling Time* + 1/frequency input)

word 7 (channel 0)
word 17 (channel 1)
word 27 (channel 2)
word 37 (channel 3)

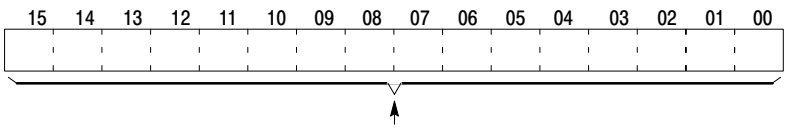


Number of Pulses to Terminate Sampling — applied when *Sampling Termination* (bit 13 of word 5, 15, 25 or 35) is set. Causes the sampling to cease when the specified number of input pulses are received or the *Minimum Frequency Sampling Time* is exceeded, which ever occurs first. RANGE: 0-32,767

High-resolution Frequency

---

word 8 (channel 0)
word 18 (channel 1)
word 28 (channel 2)
word 38 (channel 3)

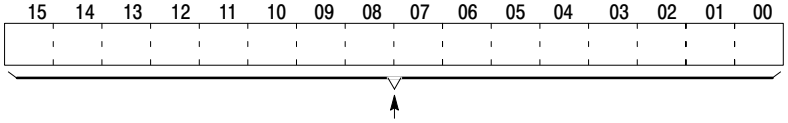


Highest Allowable Frequency — the highest frequency allowed on the channel. When the specified frequency is exceeded, the channel's overspeed alarm will activate. Also used to calculate *Percent of Full Scale* (BTR word 6,15,24,33).
RANGE: 0 - 32,767 DEFAULT: 0 (=120,000)
Used with the *4 x High Hertz* (bit 12 of word 5, 15, 25, or 35) to have an effective range of 0-120,000.

all

---

word 9 (channel 0)
word 19 (channel 1)
word 29 (channel 2)
word 39 (channel 3)

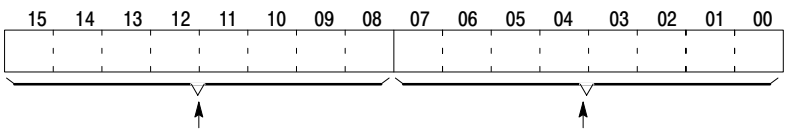


Acceleration Alarm Value determines at what acceleration values (Hz/s) the BTR alarm bits are activated.
The alarm bits occur when the absolute value of the acceleration exceeds the Acceleration Alarm Value.
This word also determines whether acceleration is calculated. A value of 0 deactivates all acceleration calculations.
RANGE: 0 - 32,767 (0 disables)

all

---

word 10 (channel 0)
word 20 (channel 1)
word 30 (channel 2)
word 40 (channel 3)



Frequency Scaler[1] **Multiplier** — the frequency value returned in the BTR is multiplied by the specified value.
RANGE: 0-255 DEFAULT: 1

all

Frequency Scaler Divisor — the frequency value returned in the BTR is divided by the specified value.
RANGE: 0-255 DEFAULT: 1

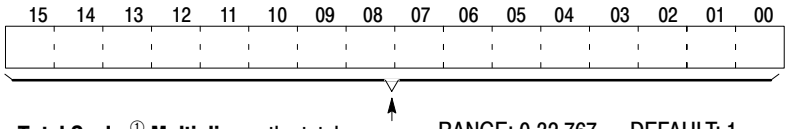
all

Important: The *Frequency Multiplier* must be ≤ the *Frequency Divisor*.

Example: If *Frequency Divisor* = 50, *Frequency Multiplier* = 6 and frequency at the input = 75 Hz, the scaled value returned will be 6/50(75) = 9

[1] When scaling is used, all outputs are still controlled by the actual value (in example, 75Hz) not the scaled value (in example, 9).

word 11 (channel 0)
word 21 (channel 1)
word 31 (channel 2)
word 41 (channel 3)



Total Scaler[1] **Multiplier** — the total value returned in the BTR is multiplied by the specified value.

T, NRT

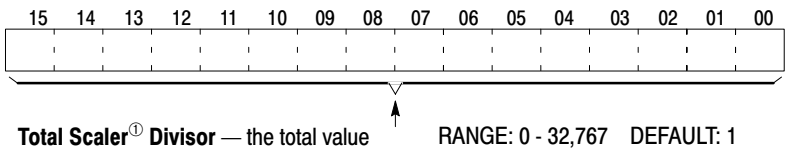
RANGE: 0-32,767 DEFAULT: 1

Important: The *Total Scaler Multiplier* must be ≤ *Total Scaler Divisor*. See *Total Scaler Divisor.*

[1] When scaling is used, all outputs are still controlled by the actual value not the scaled value.

---

word 12 (channel 0)
word 22 (channel 1)
word 32 (channel 2)
word 42 (channel 3)



Total Scaler[1] **Divisor** — the total value returned in the BTR is divided by the specified value.

T, NRT

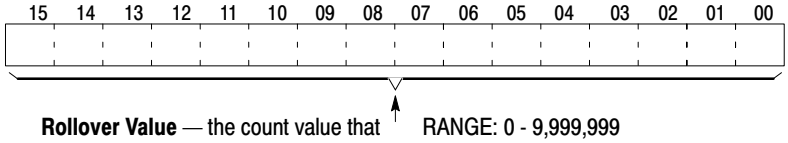
RANGE: 0 - 32,767 DEFAULT: 1

Important: The *Total Scaler Multiplier* must be ≤ *Total Scaler Divisor*. See *Total Scaler Multiplier.*

[1] When scaling is used, all outputs are still controlled by the actual value not the scaled value.

---

word 13 (channel 0)
word 23 (channel 1)
word 33 (channel 2)
word 43 (channel 3)



MSD – ranges from 0-999 x 10,000

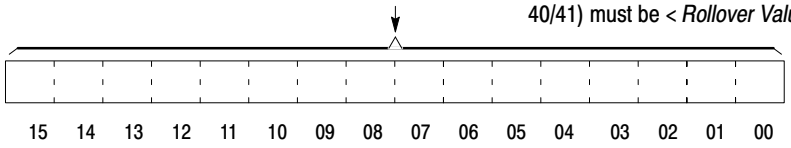
Rollover Value — the count value that the totalizer will reset or rollover to 0 at.

T, NRT

RANGE: 0 - 9,999,999
DEFAULT: 0 (which is rollover of 10,000,000)

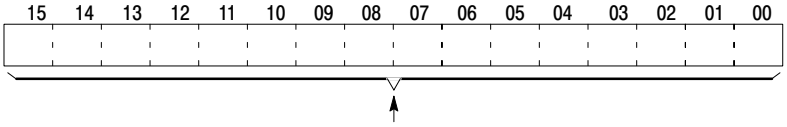
Important: The *Rollover Value* must be ≥ (actual frequency x 10ms). If you are using the prover function, the expected *Prover Total Count Value* (BTR words 13/14, 22/23, 31/32, or 40/41) must be < *Rollover Value.*

word 14 (channel 0)
word 24 (channel 1)
word 34 (channel 2)
word 44 (channel 3)



LSD - ranges from 0-9,999

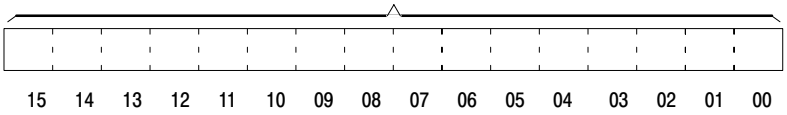
word 45 (channel 0)
word 49 (channel 1)
word 53 (channel 2)
word 57 (channel 3)



MSD - ranges from 0-999 x 10,000

Output ON Value — the value at which the output turns ON. all

word 46 (channel 0)
word 50 (channel 1)
word 54 (channel 2)
word 58 (channel 3)



LSD - ranges from 0-9,999

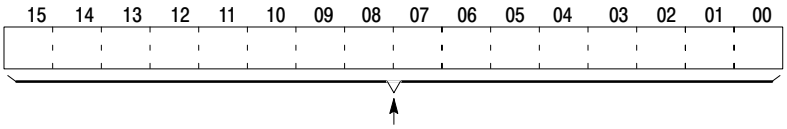
ON and OFF output values can be triggered by:
Frequency = 0-120,000
Percent of Fullscale = 0-32,767 (use LSD word 46, 50, 54, 58 **only**)
Acceleration = –32,768 - 32,767 (use LSD word 46, 50, 54, 58 **only**)
Total = 0-9,999,999
Direction = 0 (stopped), 1 (clockwise), 2 (counterclockwise) (use LSD word 46, 50, 54, 58 **only**)
Overflow = 0 (output follows *Overflow* bit, BTR words 4 & 5)
Prover Range of Operation = 0-5 — ON and OFF values must be different (use LSD word 46, 50, 54, 58 **only**)
Prover Running = 0 — Output is ON when the prover is actually counting.
unidirectional prover: ON from 2-5
bidirectional prover: ON from 2-3 and 4-5

Prover Range of Operation (value of bits in hex)**:**
0 = prover not selected
1 = prover is not running, but active
2 = prover running - past the 1st switch in forward leg
3 = prover is done with forward leg, returning at this time - mid-run value (bidirectional only)
4 = prover is returning on 2nd leg (bidirectional only)
5 = prover is done with run (BTR word 13/14 contains prover count value)

Important: When any type of scaling is used (frequency or total), outputs are always triggered by the actual value not the scaled value. Outputs triggered by *Total* turn ON in < 100µs and turn OFF in < 100µs. All other ON and OFF times are < 1ms.

On Value		Off Value
12,000	output on while >= *On* and < *Off*	15,000
15,000	output on when >= *On* or < *Off*	12,000

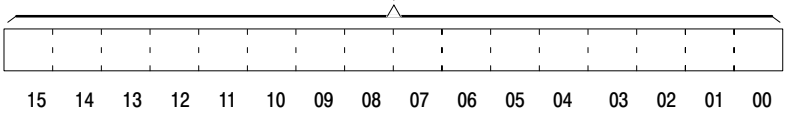
word 47 (channel 0)
word 51 (channel 1)
word 55 (channel 2)
word 59 (channel 3)



MSD - ranges from 0-999 x 10,000

Output OFF Value — the value at which the output turns OFF. all

word 48 (channel 0)
word 52 (channel 1)
word 56 (channel 2)
word 60 (channel 3)



LSD - ranges from 0-9,999

Select the Mode(s) of Operation

You select the mode(s) of operation and configure each input channel to accept input signals from your input device(s).

Totalizer and Nonresettable Totalizer Modes

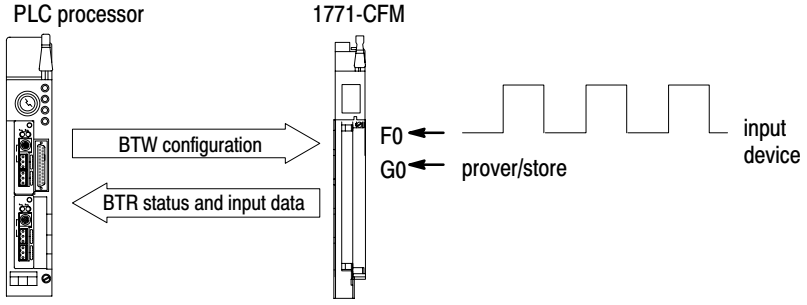
Use Totalizer mode if you:
- need counting (totalization) capabilities
- can measure frequency over a fixed sampling period (4ms-1s)
- need a frequency value
- need prover capabilities
- need count storage capabilities
- also want to calculate acceleration

Use Nonresettable Totalizer mode if you want to use the features of the Totalizer mode with NO BTW reset capabilities.

Typical applications:
- measuring ingredients in a batch process
- oil pipeline terminals (prover)

These modes measure incoming pulses over a user-specified time interval (4-1000ms). In either of these modes, the CFM module calculates:

- rate of input (0-100,000Hz)
- total count (0-9,999,999)
- acceleration value
- optional prover value
- optional store count value (current count value)

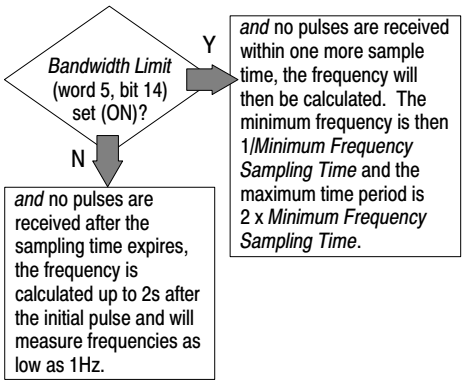


Counting

In these modes, the CFM module counts pulses based on values you enter in the BTW configuration block. You can specify these values:

Value	BTW word #	Use to
Rollover	13/14, 23/24, 33/34, 43/44	specify the value at which the CFM module will rollover to zero and begin counting again. DEFAULT: 0 = 10,000,000 RANGE: 0-9,999,999 **Important:** Every time a rollover occurs, the CFM module changes the state of the *Overflow Status* bit. (toggles between 0 - 1 every time an overflow occurs). The *Overflow Status* can also be manually reset in the BTW (word 1, bits 00-03).
Overflow Reset	1 (bits 04-07)	resets the overflow status of the CFM module for the appropriate input channel. When this bit is set, the CFM module will reset the *Overflow Status* (BTR words 4 & 5, bits 02 & 10). *Overflow Status* toggles between 0-1-0-1 every time a rollover occurs. *Overflow Status* is not affected by *Total Reset.*
Total Reset (Totalizer mode only)	1 (bits 00-03)	reset the total count to zero. This occurs on a change in bit state from a 0 to a 1. This value does not effect the *Overflow Status* (BTR word 4 & 5, bits 2 & 10).
Total Scaler Multiplier	11, 21, 31, 41	scale the returned total count to actual engineering units. For each value RANGE: 0-32,767 DEFAULT: 1 *Total Multiplier* **must be <** *Total Divisor.*
Total Scaler Divisor	12, 22, 32, 42	The scaled value can not be used to trigger any outputs (outputs triggered by count are triggered by actual count).

Frequency Sampling



In the Totalizer and Nonresettable Totalizer modes, the CFM module begins a frequency sample arbitrarily and ends the sampling within 1ms after the sampling time has expired and one pulse has been detected. You can use *Bandwidth Limit* to exert control over the CFM module's frequency sampling.

In these modes, the CFM module calculates frequency based on these values:

Value	BTW word #	Use to
Minimum Frequency Sampling Time	6, 16, 26, 36	specify the minimum time the CFM module will spend collecting pulses to determine a frequency. The time period begins arbitrarily, not on a leading edge of a pulse. Frequency is calculated after a pulse occurs and the time has expired. The total time is measured and used with the sampled counts to determine a frequency. This frequency value is in BTR word 7/8, 16/17, 25/26 or 34/35. As the actual frequency decreases, the actual sample time will increase (for frequencies < 1Hz, it can take as long as 2s to calculate the frequency). See *Bandwidth Limit*.
Bandwidth Limit	5, 15, 25, 35 (bit 14)	control the maximum time the CFM module spends calculating a frequency and the minimum frequency that can be read by the CFM module. If ON: limits the maximum time period to 2 x *Minimum Frequency Sampling Time* and minimum frequency to 1/*Minimum Frequency Sampling Time*. If OFF: maximum time period is 2s, minimum frequency is 1Hz.
Acceleration Calculation Time	5, 15, 25, 35 (bits 00-09)	specify the number of frequency samples the CFM module will spend to calculate the acceleration value. The default value (0) will calculate a rolling average of the previous five samples. Since the frequency sample time may vary, so does the actual acceleration calculation time.
Acceleration Alarm	9, 19, 29, 39	determine the acceleration value that, if exceeded, will activate the BTR *Acceleration Alarm* (word 4 & 5, bits 00 & 08). RANGE: 0-32,767 The CFM module will not calculate an acceleration if this acceleration value is zero.
Frequency Multiplier/Divisor	10, 20, 30, 40	scale the returned frequency and acceleration to actual engineering units. *Frequency Multiplier* **must be <** *Frequency Divisor.* For each value RANGE: 0-255 DEFAULT: 0 (= 1 no scaling) The scaled frequency/acceleration values can not be used to trigger any outputs (outputs triggered by frequency/ acceleration are triggered by actual frequency/acceleration).
Highest Allowable Frequency	8, 18, 28, 38	specify the highest frequency value allowed on the input channel. When this value is exceeded, the input channel's overspeed alarm will activate. This value is also used in calculating *Percent of Full Scale* (BTR, word 6, 15, 24 or 33).

Storing Count Value

In the Totalizer and Nonresettable Totalizer modes, the CFM module stores the current count based on these values:

Value	BTW word #	Use to
Prover Run Initialize	1 (bits 08-11)	initialize an input channel for prover inputs on the gate or to store current count value (if prover not used). If OFF (=0) — CFM module stores the current count every time there is a low to high transition at the appropriate gate input terminal. As each value is stored, the *Prover Status* (BTR words 4 & 5, bits 4-6) will be updated to indicate a new value. *Prover Status* toggles between 6 and 7 (hex) as each new gate transition occurs: 6 = prover not active & new store count A 7 = prover not active & new store count B If ON (= 1) — the CFM module resets to 0 any previously stored count contained in *Store Count Value* (BTR words 13 & 14, 22 & 23, 31 & 32, or 40 & 41) and then waits for the proper number of gate transitions to occur (2 for unidirectional and 4 for bidirectional). As the gate transitions occur, *Prover Status* (BTR words 4 & 5, bits 4-6) is updated accordingly, dependent upon the current state of the prover: 0 = prover not selected 1 = prover running, but not active 2 = prover running - past the 1st switch in forward leg 3 = prover is done with forward leg, returning at this time - mid-run value (bidirectional only) 4 = prover is returning on 2nd leg (bidirectional only) 5 = prover is done with run (BTR word 13/14 contains prover count value) The prover run is aborted and the *Prover Status* is set to 0 any time *Prover Run Initialize* is set to 0. The time between gate transitions must be long enough to allow the PLC processor to perform a BTR and get the updated stored value.
Debounce Filtering	5, 15, 25, 35 (bit 10)	debounce gate input for a period of 1s. If ON: CFM module takes appropriate action at the **first** low to high transition (at the gate input) and ignores all other gate transitions for 1s. If OFF: CFM module takes appropriate action at **every** low to high transition (at the gate input).

High-resolution Frequency Mode

Use this mode if you:

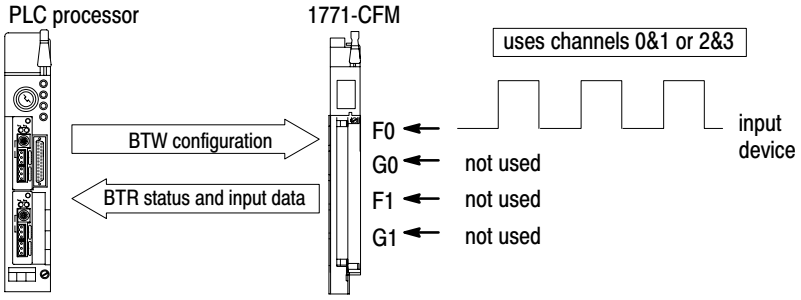
- need accurate frequency value (see page A–1 for frequency accuracy)
- need fastest possible sample update time across large frequency range
- want to calculate acceleration
- need to measure frequency in 10ths of Hz (0.1Hz)

Typical application:

turbine generators

This mode measures incoming pulses over a user-specified time interval (4-1000ms) **or** over a user-specified number of input signal pulses. In this mode, the CFM module calculates:

- rate of input (0-100,000Hz)
- acceleration value



Frequency Sampling

In the High-resolution Frequency mode, frequency sampling begins on the leading edge of the first pulse to occur and ends on the next pulse to occur after the sampling time has expired or after the user-specified number of pulses has occurred. In this mode, the CFM module calculates frequency based on values you enter in the BTW configuration block.

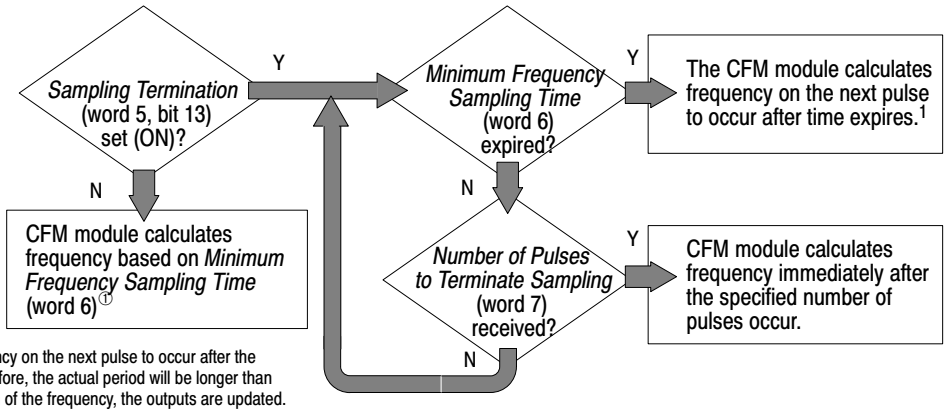
You can specify these values:

Value	BTW word #	Use to
*Minimum Frequency Sampling Time*①	6, 16, 26, 36	specify the minimum time the CFM module will spend collecting pulses to determine a frequency. The sample begins on the leading edge of a pulse.
Sampling Termination	5, 15, 25, 35 (bit 13)	terminate the sampling on either a time base or a set number of pulses, depending on which occurs first.
Bandwidth Limit	5, 15, 25, 35 (bit 14)	control the maximum time the CFM module spends calculating a frequency and the minimum frequency that can be read by the CFM module.
Acceleration Calculation Time	5, 15, 25, 35 (bits 00-09)	specify the number of frequency samples the CFM module will spend to calculate the acceleration value. The default value (0) will calculate a rolling average of the previous five samples. Since the actual frequency sample time can vary, so does the *Acceleration Calculation Time.*
Acceleration Alarm	9, 19, 29, 39	determine the acceleration value that, if exceeded, will activate the BTR *Acceleration Alarm* (word 4 & 5, bits 00 & 08). RANGE: 0-32,767 The CFM module will not calculate an acceleration if this acceleration value is zero.
Number of Pulses to Terminate Sampling	7, 17, 27, 37	terminate the sampling when the specified number of input pulses are received.
Highest Allowable Frequency	8, 18, 28, 38	specify the highest frequency value expected on the input channel. When this value is exceeded, the input channel's overspeed alarm will activate. This value is also used in calculating *Percent of Full Scale* (BTR word 6, 15, 24 or 33).
Frequency Scaler Multiplier/Divisor	10, 20, 30, 40	scale the returned frequency and acceleration to actual engineering units. *Frequency Multiplier* **must be <** *Frequency Divisor.* For each value RANGE: 1-255 DEFAULT: 1 The scaled frequency/acceleration value can not be used to trigger any outputs (outputs triggered by frequency/acceleration are triggered by actual frequency/acceleration).

① If you are setting this value for both channels (0 & 1 and 2 & 3), the *Minimum Frequency Sampling Time* for both cannot = 4ms (one can = 4ms and the other can = 5ms, but both cannot = 4ms).

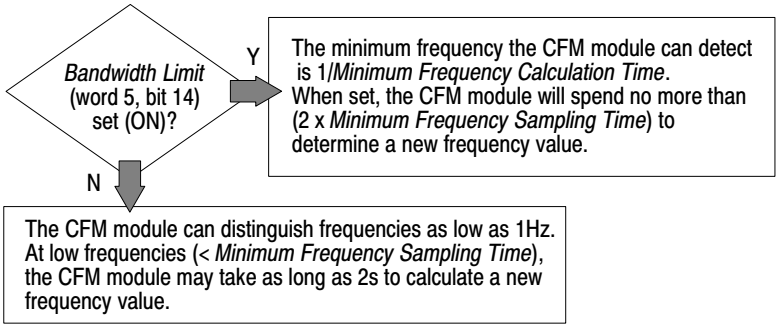
Use these diagrams to understand how you use *Sampling Termination* and *Bandwidth Limit* to exert even more control over the CFM module's frequency sampling.

Sampling Termination
(for input channel 0)



① The module calculates a new frequency on the next pulse to occur after the expiration of the specified time; therefore, the actual period will be longer than specified in word 6. Upon calculation of the frequency, the outputs are updated.

Bandwidth Limit
(for input channel 0)



Terminate Conditions①

Sampling termination	Bandwidth limit	Minimum frequency distinguishable	Frequency sample taken② and outputs updated when
OFF (= 0)	OFF (= 0)	1Hz	*Minimum Frequency Sampling Time* elapsed and at least one pulse received **OR** 2s elapsed and no pulse received
OFF (= 0)	ON (= 1)	1/*Minimum Frequency Calculation Time*	*Minimum Frequency Sampling Time* elapsed and at least one pulse received **OR** (2 x *Minimum Frequency Sampling Time*) elapsed and no pulse received
ON (= 1)	OFF (= 0)	1Hz	*Number of Pulses to Terminate Sampling* received **OR** *Minimum Frequency Sampling Time* elapsed and at least one pulse received **OR** 2s elapsed and no pulse received
ON (= 1)	ON (= 1)	1/*Minimum Frequency Calculation Time*	*Number of Pulses to Terminate Sampling* received **OR** *Minimum Frequency Sampling Time* elapsed and at least one pulse received **OR** (2 x *Minimum Frequency Sampling Time*) elapsed and no pulse received

① The terminate conditions assume a start pulse has been received.
② The next sample begins at the first pulse that occurs after a valid sample is taken.

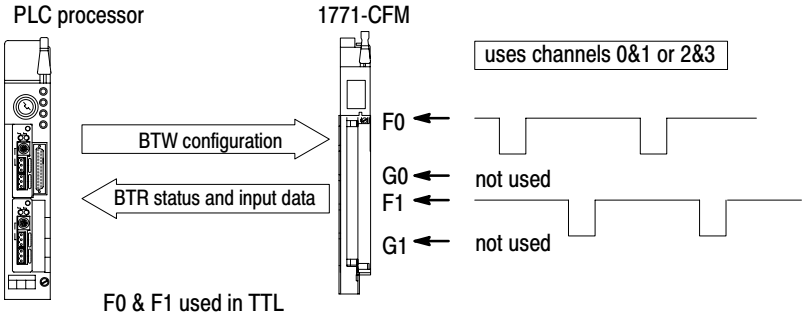
Direction Sensor Mode

Use this mode if you want to determine shaft direction.

Typical Applications:
- turbine generators
- pumps

Use this mode to measure shaft direction. In this mode, the CFM module calculates:

- rate of input (0-100,000Hz)
- acceleration value
- direction of shaft

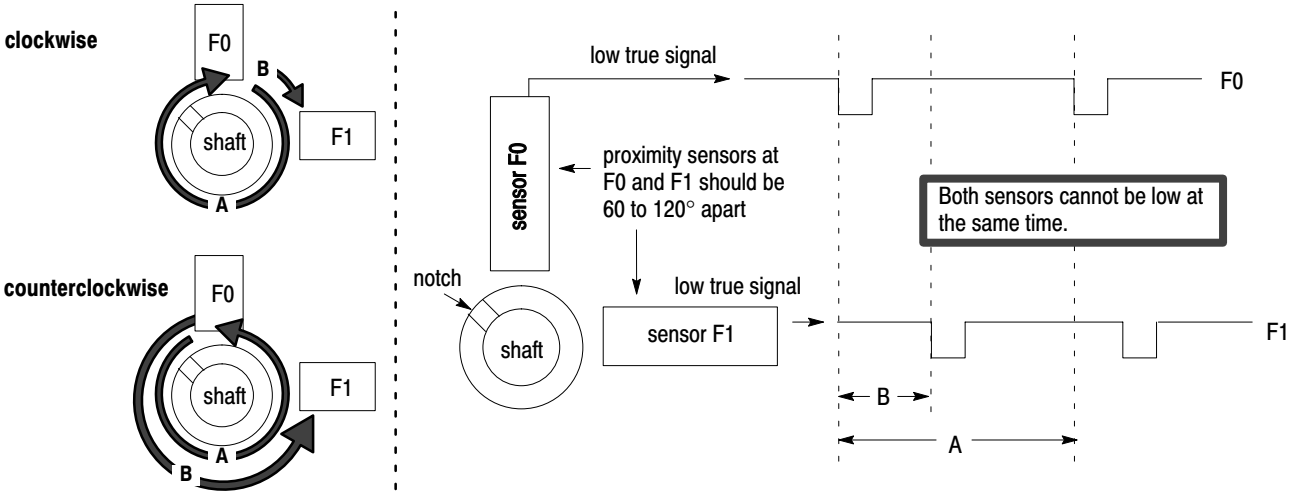


Frequency Sampling

In this mode, frequency samples are taken every revolution by measuring A and B:

A = the time between F0 input channel pulses (determines shaft frequency)
B = the time between F0 and F1 input channel pulses (determines shaft direction)

If	Direction is
B < 1/2 **A**	clockwise
B > 1/2 **A**	counterclockwise



Value	BTW word #	Use to
Minimum Frequency Sampling Time	6, 16, 26, 36	determine the minimum frequency and maximum sample time. All sample times are based on the time between F0 or F2 pulses. If *Bandwidth Limit* is OFF (= 0), *Minimum Frequency Sampling Time* is not used.
Bandwidth Limit	5, 15, 25, 35 (bit 14)	control the maximum time the CFM module spends calculating a frequency and the minimum frequency that can be read by the CFM module. If ON: limits the maximum time period to 2 x *Minimum Frequency Sampling Time* and minimum frequency to 1/*Minimum Frequency Sampling Time*. Frequencies < 1/*Minimum Frequency Sampling Time* are reported as stopped. If OFF: maximum time period is 3s, minimum frequency is 1Hz and direction can be sensed to 1/3Hz. *Minimum Frequency Sampling Time* is not used.
Acceleration Calculation Time	5, 15, 25, 35 (bits 00-09)	specify the number of frequency samples the CFM module will spend to calculate the acceleration value. The default value (0) will calculate a rolling average of the previous five samples. Since the actual frequency sample time may vary, so does the *Acceleration Calculation Time*.
Acceleration Alarm	9, 19, 29, 39	determine the acceleration value that, if exceeded, will activate the BTR *Acceleration Alarm* (word 4 & 5, bits 00 & 08). RANGE: 0-32,767 The CFM module will not calculate an acceleration if this acceleration value is zero.
Frequency Multiplier/Divisor	10, 20, 30, 40	scale the returned frequency and acceleration to actual engineering units. *Frequency Multiplier* **must be <** *Frequency Divisor.* For each value RANGE: 1-255 DEFAULT: 1 The scaled frequency/acceleration value can not be used to trigger any outputs (outputs triggered by frequency/acceleration are triggered by actual frequency/acceleration).
Highest Allowable Frequency	8, 18, 28, 38	specify the highest frequency value allowed on the input channel. When this value is exceeded, the input channel's overspeed alarm will activate.

Configure the Module

To configure the CFM module, you set the appropriate bits in the BTW instruction. You do this:

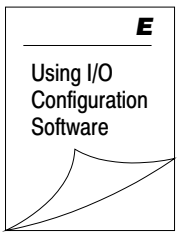
- through I/O Configuration software if you are using a PLC-5 family processor (see *PLC-5 Programming Software I/O Configuration Manual*, publication 6200-6.4.12, for supported processors)

or

- by editing bits at the address of the BTW instruction

Using I/O Configuration Software

To configure the CFM module using I/O Configuration software, you enter the appropriate information on the CFM module edit screens. Use these documents to help you use I/O Configuration software:

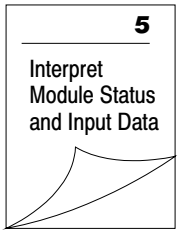


publication 6200-6.4.12

Setting Bits in the BTW Configuration Block

If you are not using the I/O configuration utility, edit the data file addresses in the BTW instruction to match your particular application. Use the word descriptions on pages 4–3 through 4–7 to help you edit the bits that apply to your application(s).

What's Next



Interpret Module Status and Input Data

What This Chapter Contains

Use this chapter to interpret module status and input data from the CFM module.

Understand the CFM Module's BTR Structure

Your PLC processor gets data from the CFM module using BTR instructions in your ladder logic program. The CFM module transfers up to 41 words to the PLC processor's data table file. The words contain module status and input data from each channel.

You should program a block transfer read length of zero (0). When a BTR of 0 is programmed, the CFM module will determine the correct number of words (41) to return.

For	See page(s)
a general overview of the BTW configuration block	5–2
detailed descriptions of each word in the BTW configuration block	5–3 through 5–5
an example of a data table print out	5–6

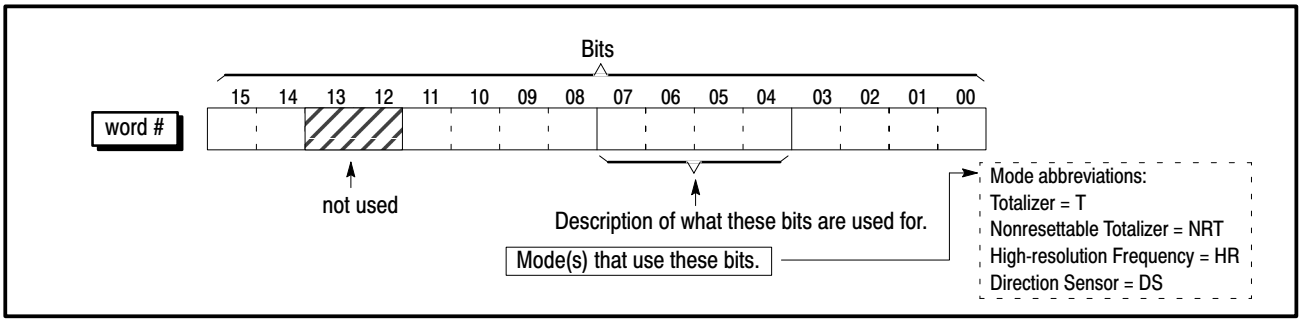
BTR Word Assignments

Word(s)	Bit 15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Block ID & Resets																
1	Header															Power-up bit
Output Status & Diagnostics																
2	Output Status								Error Words & Diagnostics							
Mode Indication																
3	Channel 3				Channel 2				Channel 1				Channel 0			
	Channel 1 Status								**Channel 0 Status**							
4		Prover Status		Overrange Alarm		Overflow Status		Overspeed Alarm		Acceleration Alarm		Prover Status		Overrange Alarm		Overflow Status		Overspeed Alarm		Acceleration Alarm
	Channel 3 Status								**Channel 2 Status**							
5		Prover Status		Overrange Alarm		Overflow Status		Overspeed Alarm		Acceleration Alarm		Prover Status		Overrange Alarm		Overflow Status		Overspeed Alarm		Acceleration Alarm
	Input Channel Data															
	Channel 0 (words 6-14)				**Channel 1 (words 15-23)**				**Channel 2 (words 24-32)**				**Channel 3 (words 33-41)**			
6, 15, 24, 33	Percent of Full Scale (Rate % of High RPM value)															
7, 16, 25, 34	Frequency (0-120) MSD															
8, 17, 26, 35	Frequency (0-999) LSD															
9, 18, 27, 36	Total MSD (0-999)															
10, 19, 28, 37	Total LSD (0-9,999)															
11, 20, 29, 38	Acceleration (rate of change of frequency)															
12, 21, 30, 39													Direction			
13, 22, 31, 40	Prover Total Count Value or Store Count Value — MSD (0-999)															
14, 23, 32, 41	Prover Total Count Value or Store Count Value — LSD (0-9,999)															

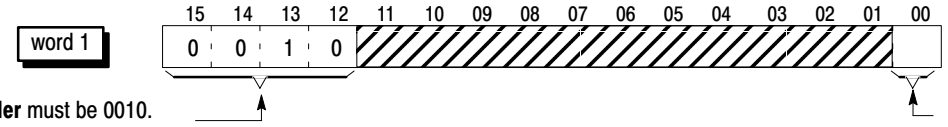
not used

* Numeric values are in binary except for *Diagnostics* (word 2, bits 00-07)*

BTR Word Description Key



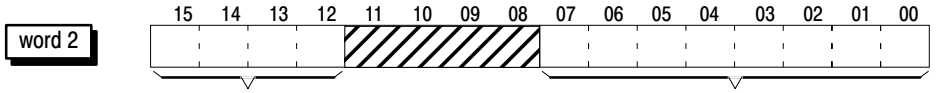
BTR Word Descriptions



Header must be 0010.

Power-up Bit indicates if a valid BTW has occurred since power-up or since last switched from Program to Run mode.

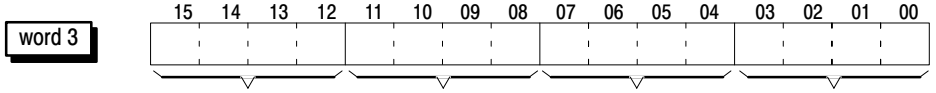
VALUES: 1= no or invalid BTW
0 = yes



Output Status reflects current operating state of outputs.
b12 = Output 0 b13 = Output 1
b14 = Output 2 b15 = Output 3

VALUES:
0 = OFF
1 = ON

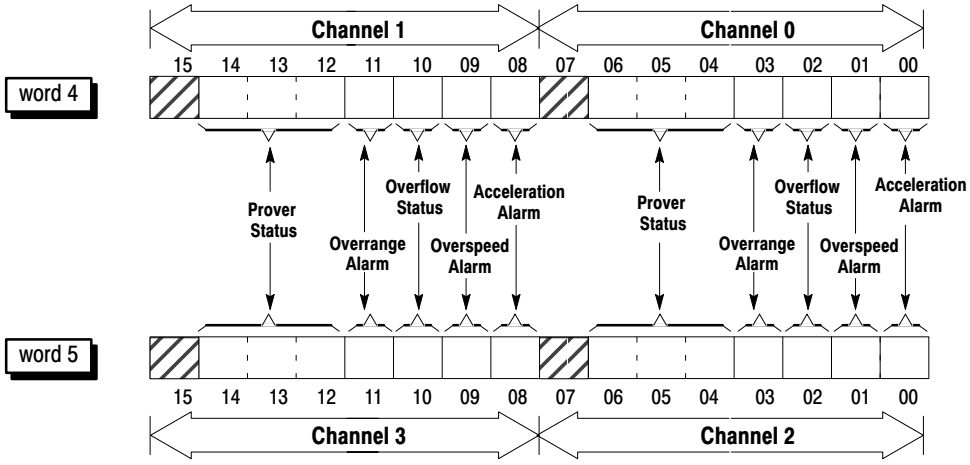
Error Words & Diagnostics displays invalid BTW word # (0-60 BCD).
99 = invalid BTW length.



Mode Indication for Channel 3 **Mode Indication for Channel 2** **Mode Indication for Channel 1** **Mode Indication for Channel 0**

Indicates mode of operation that channel is currently running in.

0 = unused channel
1 = Totalizer
2 = Nonresettable Totalizer
3 = High-resolution Frequency (channels 0 & 1 or 2 & 3)
4 = Direction Sensor (channels 0 & 1 or 2 & 3)



Overrange Alarm
on if the frequency is > than 100kHz (frequencies > 100kHz may not be accurately returned).
all

Overflow Status
toggles between 0-1-0-1 every time a rollover occurs. This bit is reset by BTW word 1 (bits 04-07).
T, NRT

Overspeed Alarm
on if frequency is > *Highest Allowable Frequency* (BTW word 8, 18, 28, 38).
all

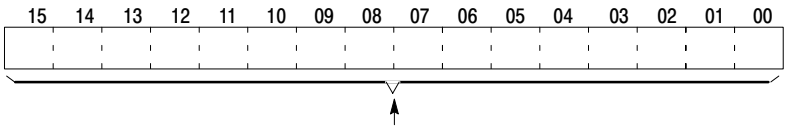
Acceleration Alarm
on if |acceleration value| is > *Acceleration Alarm Value* (BTW word 9, 19, 29, 39).
all

Prover Status indicates the current state of prover (value of bits in hex). T, NRT

0 = prover not selected
1 = prover not running, but active
2 = prover running - past the 1st switch in forward leg
3 = prover is done with forward leg and returning at this time - intermediate value returned (bidirectional only)
4 = prover is returning on reverse leg (bidirectional only)
5 = prover is done with run (BTR word 13/14 contains prover count value)
6 = prover not active & new store count A
7 = prover not active & new store count B

if prover not active, these bits toggle 6-7-6-7 every high transition of the gate

word 6 (Channel 0)
word 15 (Channel 1)
word 24 (Channel 2)
word 33 (Channel 3)



Percent of Full Scale (Rate % of High RPM value) — the calculated frequency scaled by the *Highest Allowable Frequency* (BTW 8, 18, 28, 38) and then expressed as a number from 0 to 32,767.

0 = 0%
32, 767 ≥ 100%
% = BTR word 6,15,24,33 / 32,767

T, NRT, HR

For example, if:

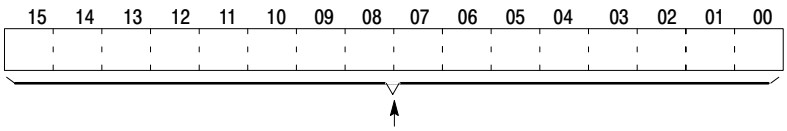
BTW word 5 — bit 12, *4 x Highest Hertz* = 1 (ON)
bit 15, *Frequency in 10ths* = 0 (OFF)
BTW word 8 — *Highest Allowable Frequency* = 21,750Hz
BTR word 7 = 1
BTR word 8 = 1410 } *Frequency* = 11,410Hz

Percent Full Scale (BTR 6) = $\frac{32,767}{(21,750 \times 4) / 11,410}$

Percent Full Scale (BTR 6) = **4,297**

---

word 7 (channel 0)
word 16 (channel 1)
word 25 (channel 2)
word 34 (channel 3)



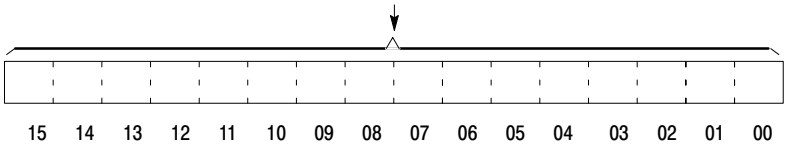
MSD - range depends on status of *Frequency in 10ths* (BTW word 5,15,25,35 bit 15) and mode of operation

Frequency indicates the calculated frequency.
RANGE: 0-120,000
If *Frequency in 10ths* (word 5,15,25,35 — bit 15) is:

not set — MSD range = 0-12 x 10,000 / LSD range = 0-9,999
Example: If word 7 = 6 and word 8 = 532, Frequency = 6(10,000) + 532 = 60,532 all

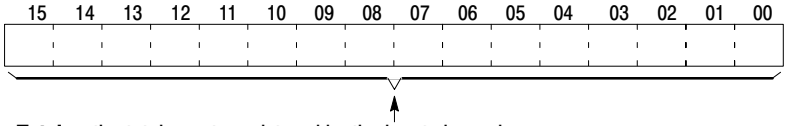
set — MSD range = 0-120 x 1,000 / LSD range = 0-9,999 x 0.10
Example: If word 7 = 6 and word 8 = 532, Frequency = 6(1,000) + 532(0.10) = 6,053.2 HR

word 8 (channel 0)
word 17 (channel 1)
word 26 (channel 2)
word 35 (channel 3)



LSD - range depends on status of BTW *Frequency in 10ths* bit

word 9 (channel 0)
word 18 (channel 1)
word 27 (channel 2)
word 36 (channel 3)

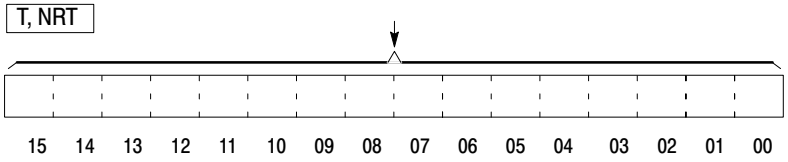


MSD - ranges from 0-999 x 10,000

Total — the total counts registered by the input channel.
Example: If word 9 = 93 and word 10 = 1234, Total = 93(10,000) + 1,234 = 931,234
RANGE: 0 - 9,999,999

T, NRT

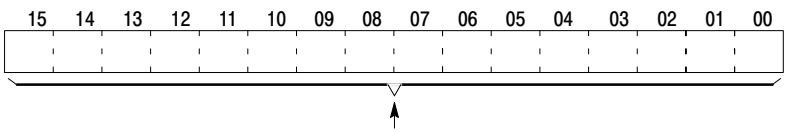
word 10 (channel 0)
word 19 (channel 1)
word 28 (channel 2)
word 37 (channel 3)



LSD - ranges from 0-9,999

---

word 11 (channel 0)
word 20 (channel 1)
word 29 (channel 2)
word 38 (channel 3)



Acceleration (rate of change of frequency) — the calculated acceleration value (Hz/s).
RANGE: –32,767 to 32,767

all

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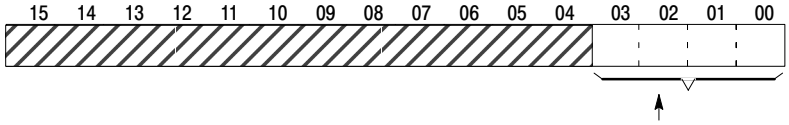
word 12 (channel 0)
word 21 (channel 1)
word 30 (channel 2)
word 39 (channel 3)



If *Bandwidth Limit* is:
ON — orientation and frequency can be sensed to 1/*Minimum Frequency Sampling Time*. Frequencies < 1/*Minimum Frequency Sampling Time* are reported as stopped.

OFF — direction can be sensed to 0.33Hz and frequencies < 1Hz are reported as 0.

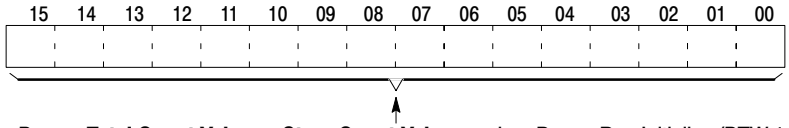
Direction indicates the current detected direction of the input pulses in Direction Sensor modes.

DS

0 = stopped
1 = clockwise
2 = counterclockwise

---

word 13 (channel 0)
word 22 (channel 1)
word 31 (channel 2)
word 40 (channel 3)



MSD - ranges from 0-999 x 10,000

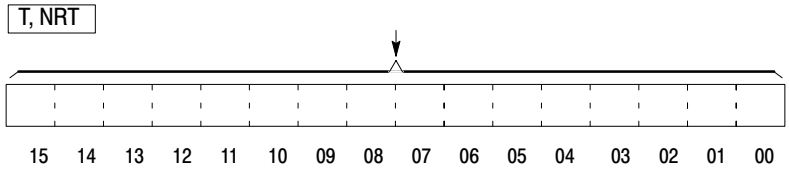
Prover Total Count Value *or* Store Count Value — when Prover Run Initialize (BTW 1, bits 8-11) is:

enabled — the value returned is the prover count (intermediate and final run values).

not enabled — the value returned is the last count stored when the Gate input went low to high. These words are reset to 0 when *Prover Run Initialize* (BTW 1, bits 8-11) changes in bit state from a 0 to a 1.

T, NRT

word 14 (channel 0)
word 23 (channel 1)
word 32 (channel 2)
word 41 (channel 3)



LSD - ranges from 0-9,999

Example — reading data from the CFM module

In this example, the CFM module:

- has a constant input frequency of 729Hz fed to all channels
- has input channels configured as follows:

		CH 0	CH 1	CH 2 & 3
Operating Mode		Totalizer	Nonresettable Totalizer	High-resolution Frequency
Minimum Frequency Sampling Time		50ms	250ms	10ms
Highest Allowable Frequency		25000	10000	50000
Acceleration Alarm Value		3500		
Acceleration Calculation Time		10 (every 10 frequency samples)		
Rollover Value		360000		
Frequency Scaler	*Multiplier*	6		
	Divisor	36		
Frequency in 10ths				0.1Hz
Bandwidth Limit				1/sample time
Sampling Termination				time or 200 counts

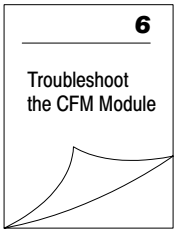
The following data table is a printout from the PLC-5 processor program example (page 3–4). This printout shows the BTW words (1-60) and BTR words (101-141), in binary, used to communicate with the CFM module.

1771-CFM Sample PLC-5 Program 24 May 1993 Page 1

Data Table Report PLC-5/20 File CFMSAMPL Data Table File N22:0

Address	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
N22:0	0	8192	0	0	801	10	50	0	25000	3500
N22:10	1572	0	0	36	0	0	250	0	10000	0
N22:20	0	0	0	0	0	–4096	10	200	12500	0
N22:30	0	0	0	0	0	0	0	0	0	0
N22:40	0	0	0	0	0	0	0	0	0	0
N22:50	0	0	0	0	0	0	0	0	0	0
N22:60	0	0	0	0	0	0	0	0	0	0
N22:70	0	0	0	0	0	0	0	0	0	0
N22:80	0	0	0	0	0	0	0	0	0	0
N22:90	0	0	0	0	0	0	0	0	0	0
N22:100	0	8192	0	801	4	0	969	0	123	26
N22:110	2789	0	0	0	0	2392	0	730	62	2853
N22:120	0	0	0	0	477	0	7289	0	0	0
N22:130	0	0	0	0	0	0	0	0	0	0
N22:140	0	0	0	0	0	0	0	0	0	0

What's Next



Troubleshoot the CFM Module

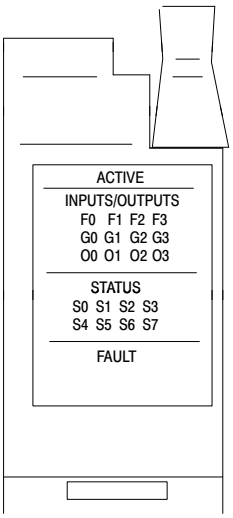
What This Chapter Contains

Use this chapter to troubleshoot the CFM module by interpreting the:

- status indicators
- diagnostic word in the BTR file

Status Indicators

The CFM module provides these LED indicators:



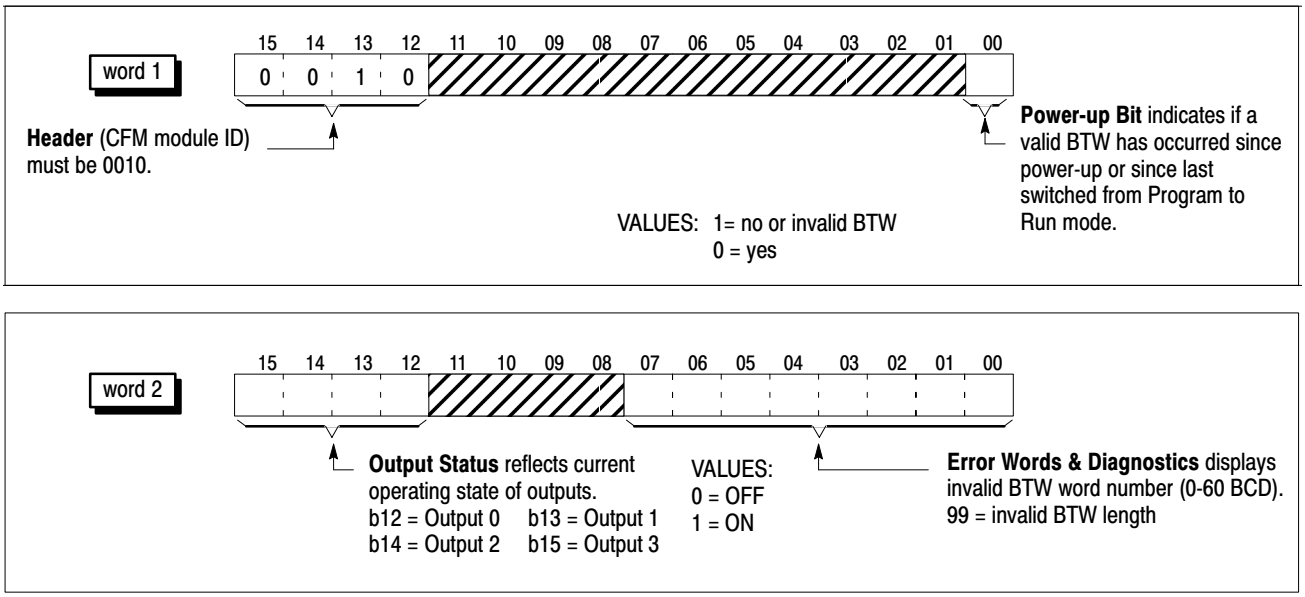
Indicators	If indicator		Is ON	Is OFF
	ACTIVE		the CFM module is successfully receiving power and operational	**a.** Check FAULT LED — if on, follow the steps listed under if FAULT is ON. **b.** Check the power supply.
	INPUTS (F0-F3 & G0-G3)		a signal is present at the designated input terminal	a signal is not present at the designated input terminal
	OUTPUTS (O0-O3)		the module has commanded an output on	the output is off
	STATUS	S1	*Power-up Bit* (BTR word 1, bit 00) is ON (=1) — BTW hasn't occurred since power-up, or invalid BTW, or PLC processor in Program mode	*Power-up Bit* (BTR word 1, bit 00) is OFF (=0) — valid BTW has occurred since power-up or since last switched from Program to Run mode
		S2	BTW is occurring	BTW is not occurring
		S3	BTR is occurring	BTR is not occurring
	FAULT		**1.** Turn off power to the I/O chassis backplane and wiring arm. **2.** Reseat the CFM module in the I/O chassis. **3.** Restore power to the I/O chassis backplane and wiring arm. **Important:** If the fault LED remains on, there may be an internal problem. Contact your local Allen-Bradley representative for additional assistance.	normal operation

Diagnostics

The CFM module returns diagnostics to the PLC processor in words one and two of the BTR file. These diagnostics give you the number of the word in the BTW configuration block that has caused an error to occur.

Important: In the event that there are multiple incorrect BTW words, the CFM module only returns **the first incorrect word.**

Diagnostic Words in the BTR File



What's Next

To find out more about the CFM module:

See appendix		For
A Specifications	→	specifications on the CFM module
B Schematics	→	input and output circuit drawings

Specifications

What This Appendix Contains

This appendix contains the frequency accuracy and general specifications of the CFM module.

Frequency Accuracy

The following table lists typical application configurations and their associated frequency accuracy for the CFM module when used:

- to emulate a 1771-QRC or 1771-QRD module
- as a CFM module

Important: The accuracy in all configurations will vary with input frequency, mode of operation and frequency sample time.

QRC / QRD module emulation					
CFM module configured for	**Frequency sampling time**	**Frequency range** (0-120,000Hz)	**Maximum frequency error** (Hz or %)		
			25°C	**40°C**	**60°C**
QRC operation	constant @ 12ms	0 – 6,000 6,001 – 14,000 14,001 – 15,800	±1Hz① ±1Hz① ±1Hz①	±1Hz① ±1Hz① ±0.007%	±1Hz① ±0.015% ±0.015%
QRD operation	constant @ 1s	0 – 6,000 6,001 – 10,000	±1Hz① ±0.080%	±1Hz① ±0.090%	±1Hz① ±0.10%
CFM module					
Totalizer & Nonresettable Totalizer② Mode	100ms	0 – 10 11 – 2,000 2,001 – 18,000 18,001 - 120,000	±1Hz① ±10Hz ±0.180% ±0.100%	±1Hz① ±10Hz ±0.180% ±0.120%	±1Hz① ±10Hz ±0.20% ±0.150%
	500ms	0 – 50 51 – 8,000 8,001 – 20,000 20,001 – 120,000	±1Hz① ±2Hz ±0.03% ±0.025%	±1Hz① ±2Hz ±0.03% ±0.0275%	±1Hz① ±3Hz ±0.035% ±0.03%
	1000ms	0 – 6,000 6,001 – 120,000	±1Hz① ±0.020%	±1Hz① ±0.025%	±1Hz① ±0.030%
High-resolution Frequency (time only) Mode	4ms	0 – 6,000 6,001 – 14,000 14,001 – 120,000	±1Hz① ±1Hz① ±0.0150%	±1Hz① ±1Hz① ±0.020%	±1Hz① ±0.020% ±0.025%
	10ms	0 – 6,000 6,001 – 14,000 14,001 – 20,000 20,001 – 120,000	±1Hz① ±1Hz① ±1Hz① ±0.007%	±1Hz① ±1Hz① ±0.007% ±0.007%	±1Hz① ±0.015% ±0.015% ±0.015%
	100ms	0 – 6,000 6,001 – 14,000 14,001 – 20,000 20,001 – 120,000	±1Hz① ±1Hz① ±1Hz① ±0.005%	±1Hz① ±1Hz① ±0.007% ±0.007%	±1Hz① ±0.015% ±0.015% ±0.015%
	1000ms	0 – 6,000 6,001 – 14,000 14,001 – 20,000 20,001 – 120,000	±1Hz① ±1Hz① ±1Hz① ±0.005%	±1Hz① ±1Hz① ±0.007% ±0.007%	±1Hz① ±0.015% ±0.015% ±0.015%
Direction Sensor Mode	not applicable	0 – 2,000 2,001 – 30,000 30,001 – 120,000	±1Hz① ±0.550% ±2.500%	±1Hz① ±0.550% ±2.500%	±1Hz① ±0.550% ±2.500%

① Specified 1Hz is worst case — typical performance is expected to be better than ±1Hz.

② In Totalizer and Nonresettable Totalizer modes, frequencies input slightly above 1/*Minimum Frequency Sampling Time* may result in an inaccurate frequency (approximately twice the actual frequency) because the incoming pulses and sample time are not synchronized.

General Specifications

Number of Input Channels	4
Module Location	1771-A1B, -A2B, A3B, -A3B1, -A4B (series A and B) I/O chassis 1771-AM1, -AM2 I/O chassis with integral power supply, adapter
Maximum Count Value	0–9,999,999 (programmable)
BTW Processing Time (worst case)	5.5ms — on a configuration change
Module Scan Time	1.3–5ms (depending on configuration and frequency)
Maximum Input Frequency	100kHz @ flowmeter Input (maximum frequency is 120kHz - 100kHz @ gate input overrange occurs at 100kHz)
Inputs per Channel	2 – flowmeter input — used for all modes gate input — used in Totalizer and Nonresettable Totalizer modes
Input Voltage	50mV-200V ac peak — Magnetic Pickup 5-40V dc (TTL compatible) Bently 3300 5 & 8 mm — Proximity Pickups
Input Impedance	5KΩ ± 30% resistive
Number of Outputs	4
Maximum Output Off-state Leakage Current	less than 300μA @ 40V dc
Maximum On-state Voltage Drop	0.6Ω x current
Output Control	Any number of outputs are assignable to any of 4 channels. One "turn–on" value and one "turn–off" value per output.
Output Voltage	5 to 40V dc, customer supplied
Output Current	1A per channel sourced out of module All outputs can be on simultaneously without derating.
Output Switching Time	outputs triggered by *Total:* turn ON < 100μs; turn OFF < 100μs **all other** turn ON and OFF times < 1ms
Filtering (F0-F3 inputs) — jumper selectable	high-speed or low-pass filter jumper (filter = below 70Hz)
Debouncing (G0-G3 inputs) — software selectable	1s (approximate) between transitions with no minimum pulse width — Totalizer and Nonresettable Totalizer modes only
+24V dc Source	ripple: ±5%; noise: 240mV peak-to-peak
Backplane Current	1A maximum
Isolation Voltage	500V between input and backplane 1500V between output and backplane 500V between isolated channels 1500V between isolated outputs and gates
Power Dissipation	13W (maximum); 2W (minimum)
Thermal Dissipation	54.2 BTU/hr (maximum); 6.8 BTU/hr (minimum)
Input Conductors — Wire Size Category Length	Belden 8761 Category 2[1] 304.8m (1000ft)
Output Conductors — Wire Size Category	Belden 8761 Category 1[①]
Environmental Conditions — Operating Temperature Storage Temperature Relative Humidity	0 to 60°C (32 to 140°F) –40 to 85°C (–40 to 185°F) 5 to 95% (without condensation)
Field Wiring Arm	40–terminal (cat. no. 1771–WN)
Wiring Arm Screw Torque	7-9 inch-pounds
Keying (lower backplane connector)	between 2 and 4 between 6 and 8
Agency Certification (when product or packaging is marked)	• UL CSA **Class 1 Div 2 Hazardous**[②] • CE **marked for all applicable directives**

[①] Use this conductor-category information for planning conductor routing as described in the system-level installation manual.
[②] CSA certification— Class I, Division 2, Group A, B, C, D or nonhazardous locations.

Schematics

What This Appendix Contains

Use this appendix to understand the internal logic of the CFM module.

▶ Follow the wiring practices described in your system-level installation manual when wiring your I/O devices. This includes:

- routing conductors
- grounding practices
- use of shielded cables

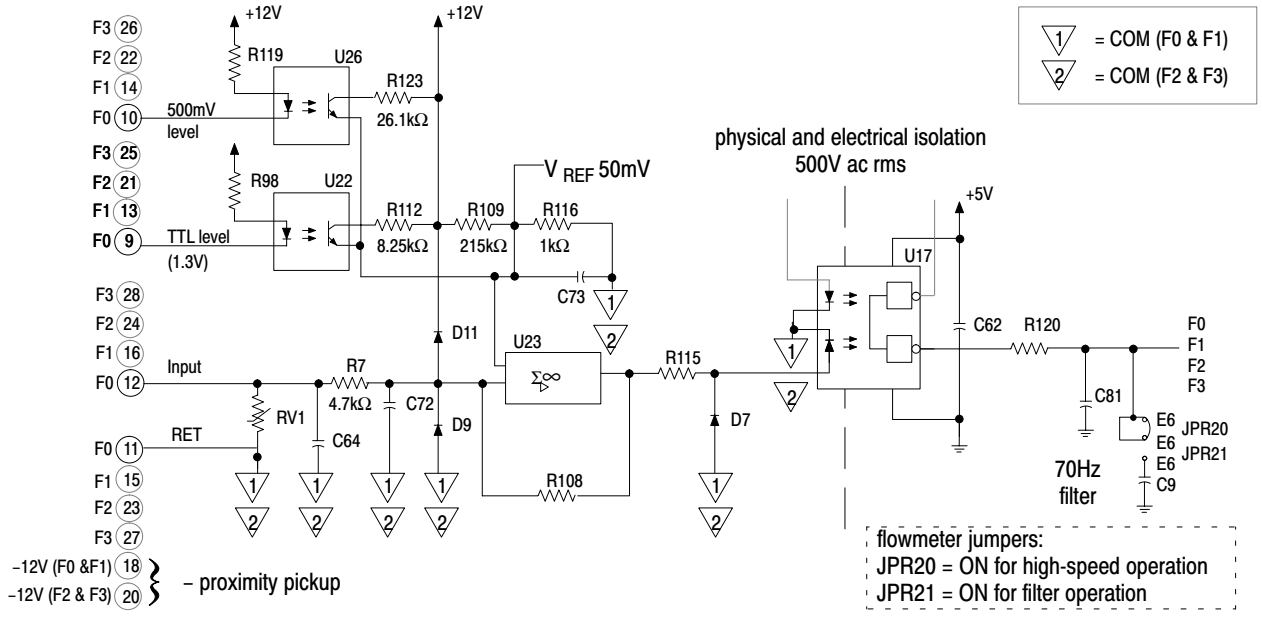
Input Circuits

The CFM module input logic consists of:

- flowmeter input circuits
- gate input circuits

Flowmeter Inputs

The flowmeter input circuit combines operational amplifier principles with solid state devices to provide constant logic pulses internal to the CFM module. The circuit is designed to interface with both active or passive sensor inputs by accepting any pulse output device (such as turbine flowmeter, magnetic pickup or digital pickup).

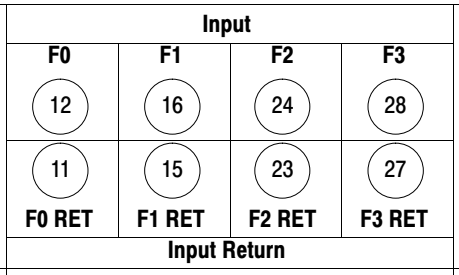


Signal characteristics

50mV threshold

Turbine flowmeter or magnetic pickup (50mV-142V ac rms)
The signal:

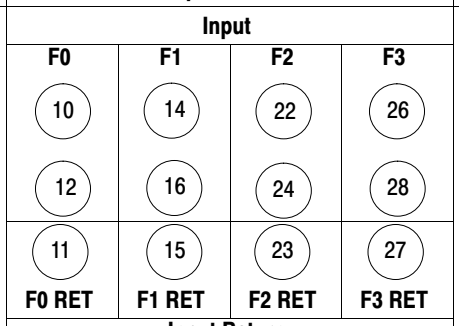
- should be approximately sinusoidal
- must be ac
- must be > 100mV and < 400V peak-to-peak



500mV threshold

Turbine flowmeter or magnetic pickup (500mV-142V ac rms)
The signal:

- should be approximately sinusoidal
- must be ac
- must be > 1V and < 400V peak-to-peak

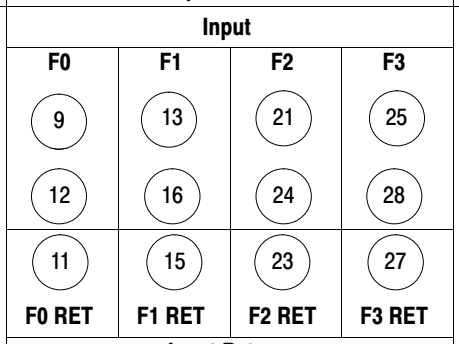


1.3V threshold (TTL)

Compatible with open collector.

The signal should be dc pulses with width > 4us.

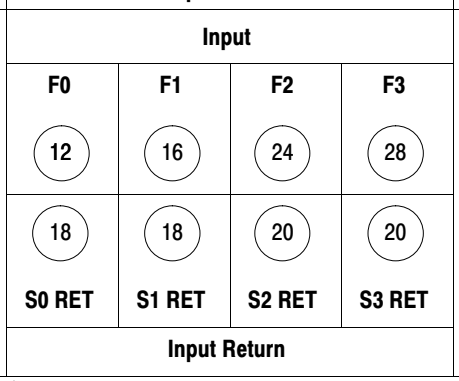
The TTL mode is compatible with TTL, 4000 series CMOS, and most 0-24V systems. The TTL mode in not compatible with any signal format with dc pulses riding on a fixed dc level > 1.3V.



"12" V threshold (+24V RET)

This specialized mode is compatible with signal format with pulses riding on a fixed dc level > +1.3V.

Example
Bently Nevada Proximity Pickup Series 3300 (5mm and 8mm) where the "active" sensor signals are with a 5V offset. The signal resides between 5-18V, therefore, it passes through the threshold of "12"V as referenced to the +24V dc RET.

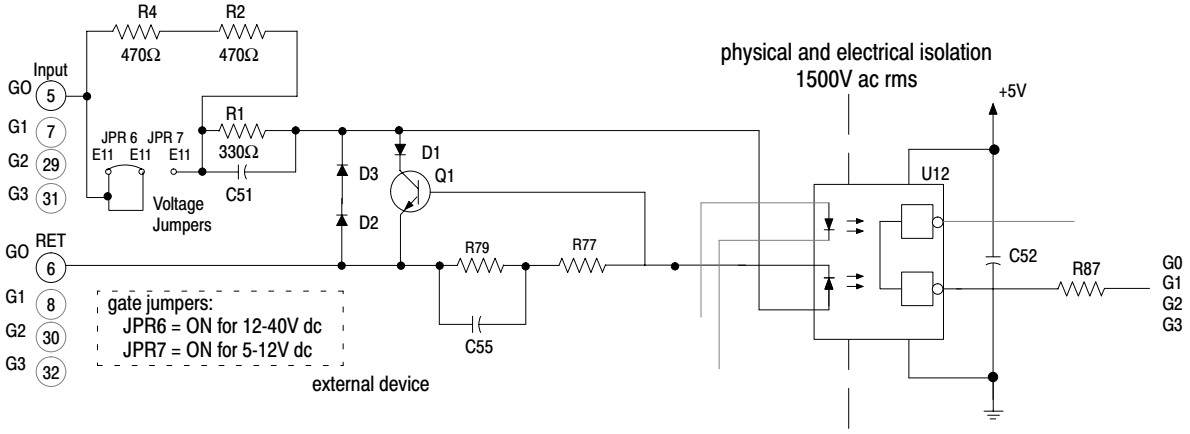


(#) wiring arm terminal number

Signal threshold (500mV or 1.3V) is selected by jumpering the appropriate level to the appropriate RET.

Gate Inputs

Gate inputs are used for running prover and store count values. Each gate is an electrically isolated circuit with a physical and electrical isolation of 1500V ac. There is one gate associated with each flowmeter input circuit (G0 corresponds to F0).



To turn on a gate circuit, you must source current through the input resistors sufficient to turn on the opto-isolator in the circuit. If no connection is made to the pair of gate terminals, no current will flow through the photodiode of the opto-isolator and that gate will be OFF (the corresponding input status indicator is OFF).

The input current magnitude can be determined by the state of the gate jumper:

CASE A — gate jumper set for 5-12V dc operation (*JPR 7 is ON*)

$$\text{gate input current} = \frac{(\text{gate input voltage} - 2\text{V}^{①})}{330\Omega^{②}}$$

Examples

1. If gate input voltage = 5V dc
   gate input current = $\frac{(5\text{V} - 2\text{V})}{330\Omega}$
   gate input current = 9mA②
2. If gate input voltage = 12V dc
   gate input current = $\frac{(12\text{V} - 2\text{V})}{330\Omega}$
   gate input current = 30mA②

CASE B — gate jumper is set for 12-40V dc operation (*JPR 6 is ON*)

$$\textbf{gate input current} = \frac{(\text{gate input voltage} - 2\text{V}^{①})}{1270\Omega^{②}}$$

Examples

1. If gate input voltage = 5V dc
   gate input current = $\frac{(12\text{V} - 2\text{V})}{1270\Omega}$
   gate input current = 8mA②
2. If gate input voltage = 40V dc
   gate input current = $\frac{(40\text{V} - 2\text{V})}{1270\Omega}$
   gate input current = 30mA②

① There is approximately a 2V drop across (Q1 + the photodiode).

② The operating range of the input is 5-10mA and Q1 functions as an overcurrent protection circuit. If an open collector device with pull-up is used, the value of the pull-up must be added to the Ω value shown in the denominator.

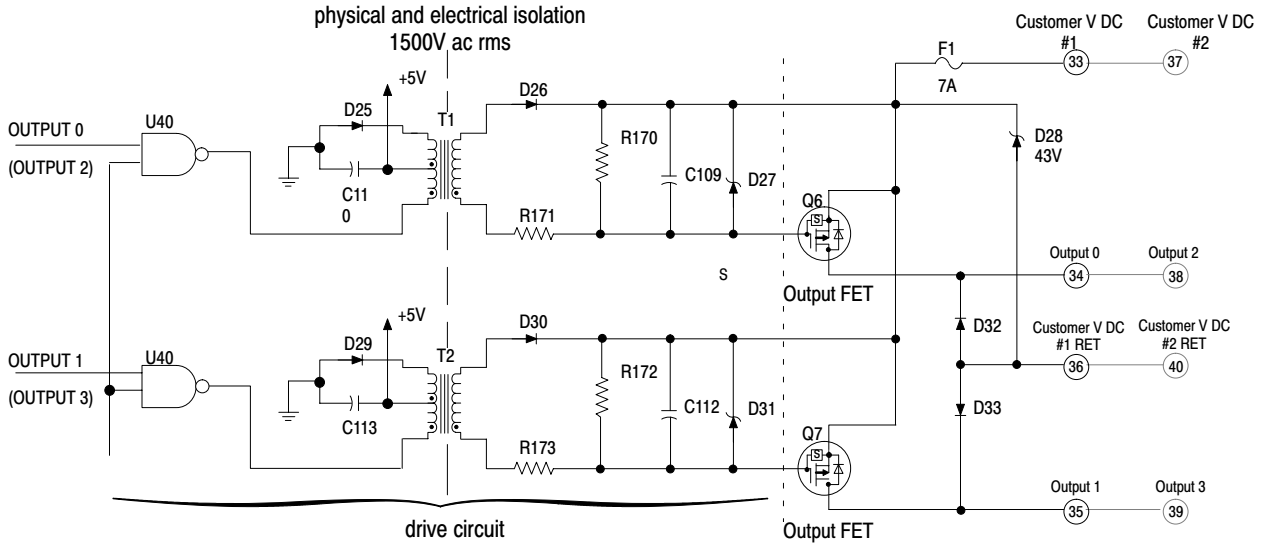
Output Circuits

The CFM module output logic consists of:

- discrete outputs
- dc to dc converters (24V dc power supplies)

Discrete Outputs

The CFM module's outputs are comprised of isolated power MOSFETs. These devices operate in current sourcing mode, and are capable of delivering up to 1A (@ 5-40V dc).



The CFM module contains two isolated pairs of output circuits. Customer supplied power, ranging from +5V to +40V dc, is connected internally (through terminal Vcc) to the power output transistors. When an output is turned on, current flows into the source, out of the drain, through the load connected to the ground of the customer supply (customer return). Diodes D32 and D33 protect the power output transistors from damage due to inductive loads.

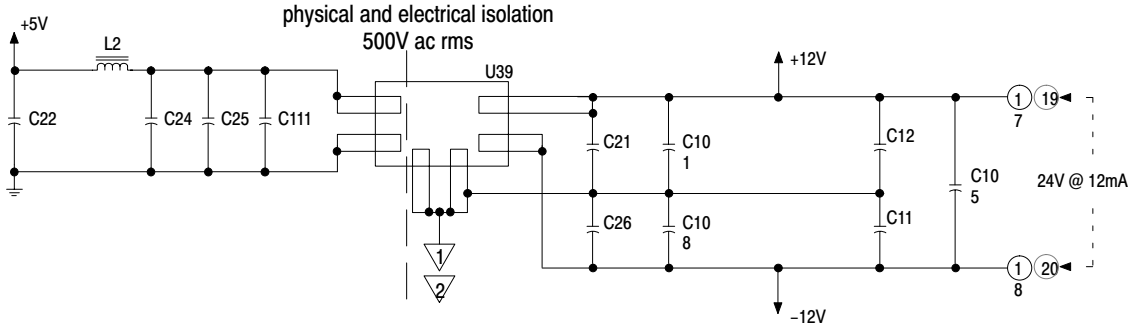
Outputs Q6 and Q7 are thermally protected FET's and will turn off @ 3A (approximately). After an output goes into thermal shutdown, you must fix the cause of the shutdown and toggle the outputs ON and OFF to reenergize the output.

If local electrical codes permit, outputs can be connected to sink current. This is done by connecting the load between the power supply + terminal and the customer Vcc terminal on the field wiring arm. The output terminal is then connected directly to ground (customer RET).

Important: This wiring method **does not** provide inductive load protection for the power output transistors.

DC to DC Converters (24V dc power supplies)

The CFM module provides two isolated 24V (±5%) power sources (each rated @ 12mA). Each power source can power one Bently Nevada 3300 (5mm or 8mm) Proximity Transducer.



Replace Your QRC Module

What This Appendix Contains

Use this appendix to install the CFM module as a replacement for the QRC module.

Important: We assume that you are using a QRC module in your existing system and that you are familiar with I/O module installation/removal procedures.

What the CFM Module Does

The CFM (QRC) module, interfaces PLC processors with magnetic pickups, single-channel shaft encoders or turbine flowmeters.

When configured for QRC operation, the CFM (QRC) module calculates the frequency, beginning on the leading edge of a pulse, for 12-18ms.

The CFM (QRC) module is generally compatible with, but does not require the use of, turbine flowmeter signal preconditioning modules. It provides rate data in 2's complement binary format to the PLC processor's data table through block data transfers. Rates as high as 15.8kHz are supported.

Check Power Requirements

ATTENTION: The maximum current drawn by the CFM (QRC) module is **1.0A**. This current (1.0A) is 0.25A greater than the maximum current drawn by your QRC module (0.75A).

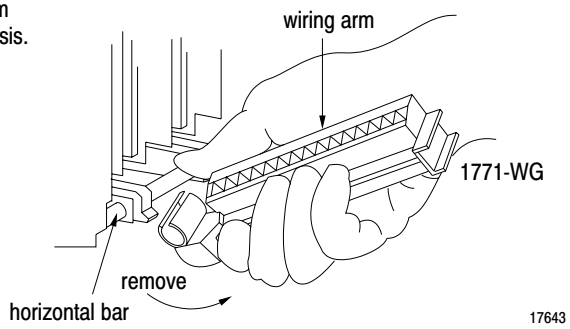
Consider the power usage of all modules in the I/O chassis to prevent overloading either the chassis backplane or power supply.

Remove Your QRC Module

ATTENTION: Remove power from the 1771 I/O chassis backplane and wiring arm before you remove your QRC module. Failure to remove power from the backplane could cause:

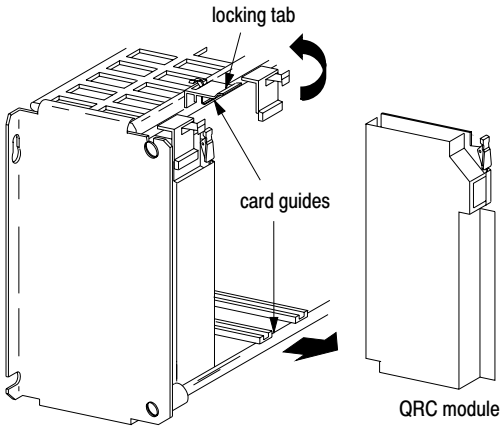
- injury
- equipment damage due to unexpected operation
- degradation of performance

1 Detach and remove wiring arm (1771-WG) from the horizontal bar at the bottom of the I/O chassis.

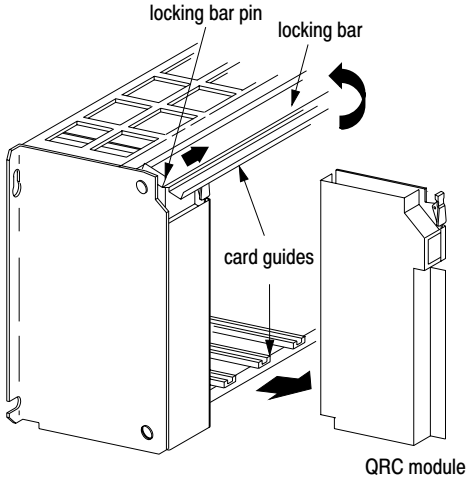


2 Remove the QRC module from the I/O chassis.

1771-A1B, -A2B, -A3B, -A3B1, -A4B I/O chassis



1771-A1B, -A2B, -A3B1, -A4B Series B I/O chassis



Pull on the QRC module to slide it out of the I/O chassis.

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At power-up, the active and fault indicators are on. An initial module self-check occurs. If there is no fault, the fault indicator turns off. See page 6–1 for information on interpreting the status indicators.

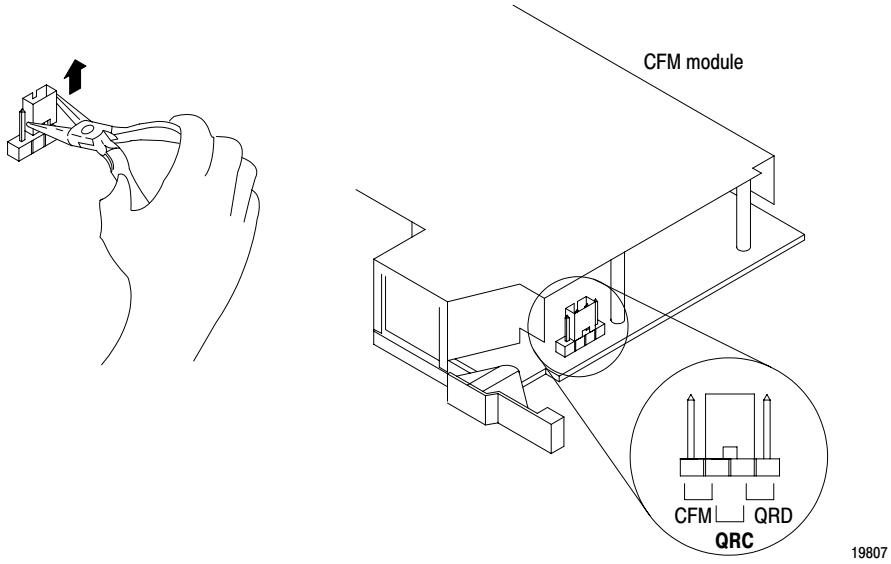
Set the Configuration Jumpers

You check and/or set these jumpers:

- module operation jumper
- input channel jumpers

Set the Module Operation Jumper

To use the CFM module as a replacement for a QRC module, set the operation jumper in the **QRC** position (default setting = **CFM** position).



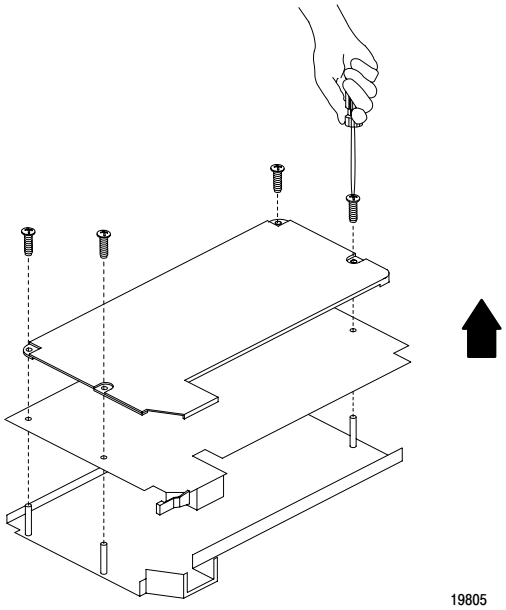
Check the Input Channel Jumpers

The CFM (QRC) module has user-selectable jumpers for each input channel. These jumpers consist of one each:

- flowmeter jumpers (F0–F3) - set for low-pass filter or high-speed operation
- gate jumpers (G0–G3) — set for +5-12V or +12-40V operation

The CFM (QRC) module is configured for high-speed operation. Before installing your CFM (QRC) module, make sure the input channel jumpers are in their default positions.

1 Remove the four screws securing the side cover to the module and remove the covers.



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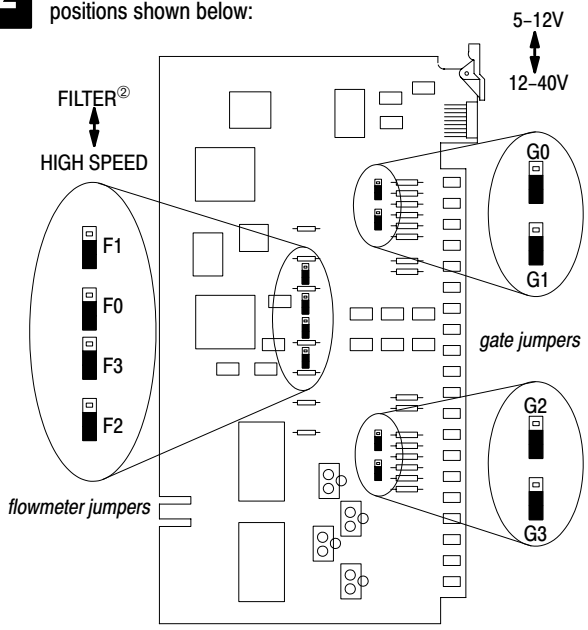
2 Make sure the input channel jumpers① are in the default positions shown below:



① Jumpers are shown in default settings.
② In the filter position, the module will not see frequencies above 70Hz.

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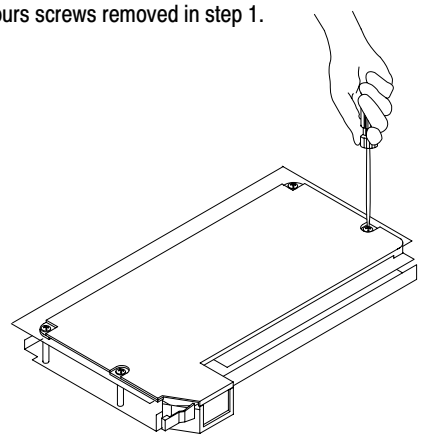
3 Reposition the cover and secure with the fours screws removed in step 1.



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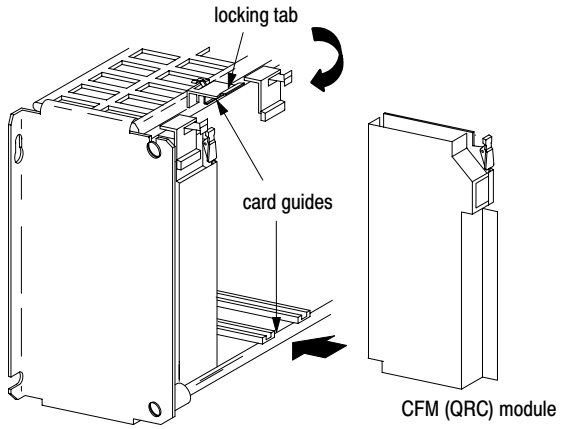
Install the CFM Module

1 Place the CFM (QRC) module in the card guides on the top and bottom of the slot that guide the module into position.

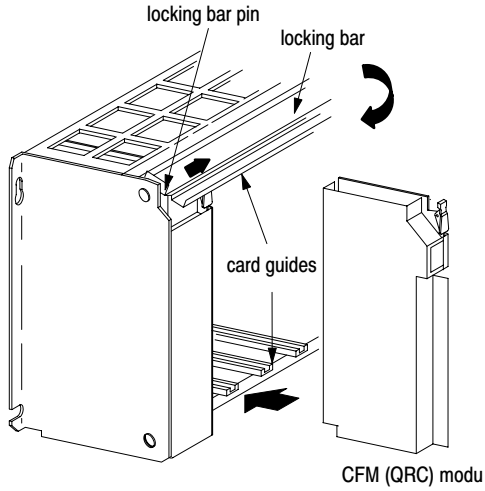
Important: Apply firm even pressure on the module to seat it into its backplane connector.

1771-A1B, -A2B, -A3B, -A3B1, -A4B I/O chassis



Snap the chassis latch over the top of the module to secure it.

1771-A1B, -A2B, -A3B1, -A4B Series B I/O chassis

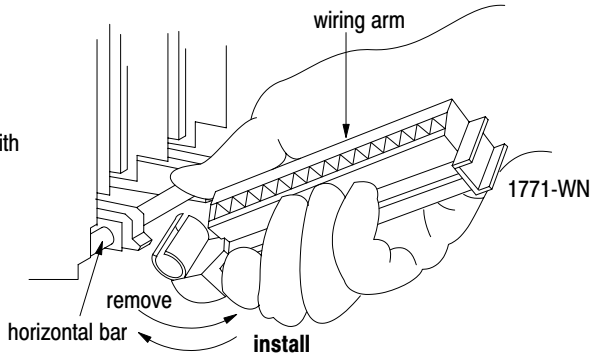


Swing the chassis locking bar down into place to secu the modules. Make sure the locking pins engage.

1

2 Attach the wiring arm (1771-WN) to the horizontal bar at the bottom of the I/O chassis.

The wiring arm pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.

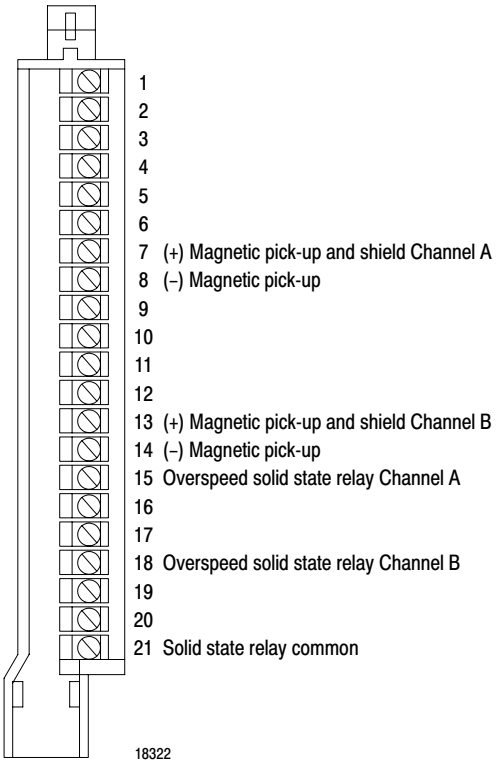


17643

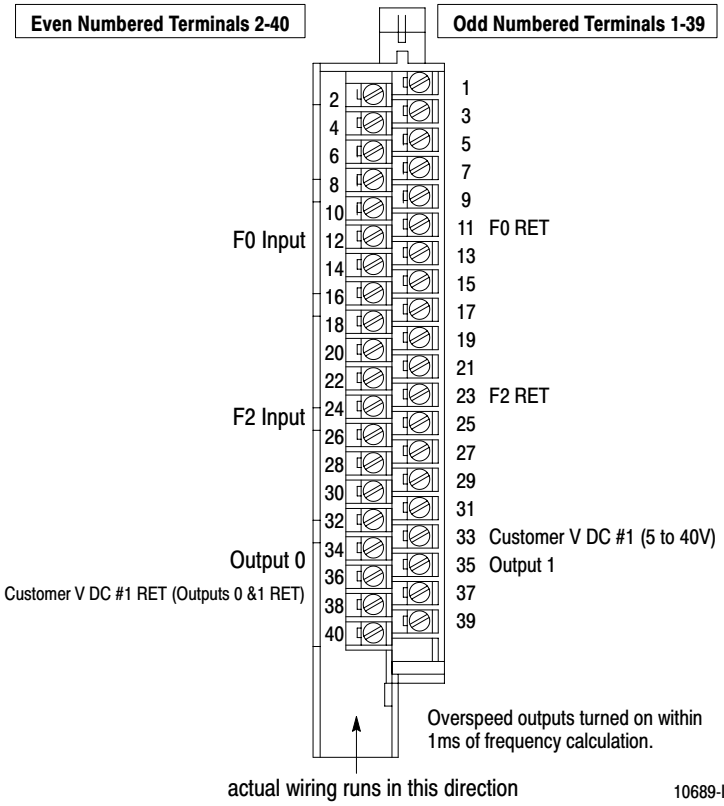
Make Connections to the New Wiring Arm

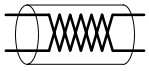
Connect your I/O devices to the 40-terminal field wiring arm (cat. no. 1771-WN) shipped with the CFM module. Use the wiring example on page C–7 for additional assistance on connecting your devices.

OLD wiring arm (1771-WG)



NEW wiring arm (1771-WN)





The sensor cable must be shielded. The shield:

- must extend the length of the cable, but be connected only at the 1771 I/O chassis
- must extend up to the point of termination

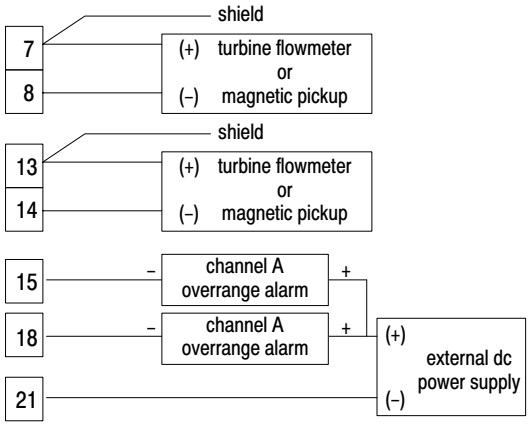
Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

Wiring Example

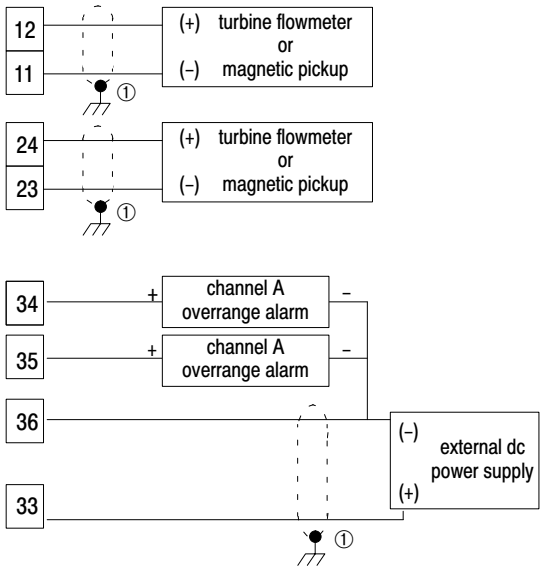
ATTENTION: Pins15 & 18 (on the QRC module) are switching negative (–) while pins 34 & 35 (on the CFM module) are switching positive (+).

Please take this into consideration when rewiring your system.

QRC module



CFM module



① For new installations, terminate the shields at the chassis. While not recommended, existing installations can continue to terminate the shields at the return (RET) terminal.

Resume Normal Operation

The CFM module, configured for QRC module emulation, operates as a QRC module. Use the following section for reference on how the CFM (QRC) module operates.

Important: The CFM module has 50mV sensitivity. This is different than the QRC module, which had 20 to 300mV sensitivity, depending on the hardware level.

Edit Your Ladder Logic Program

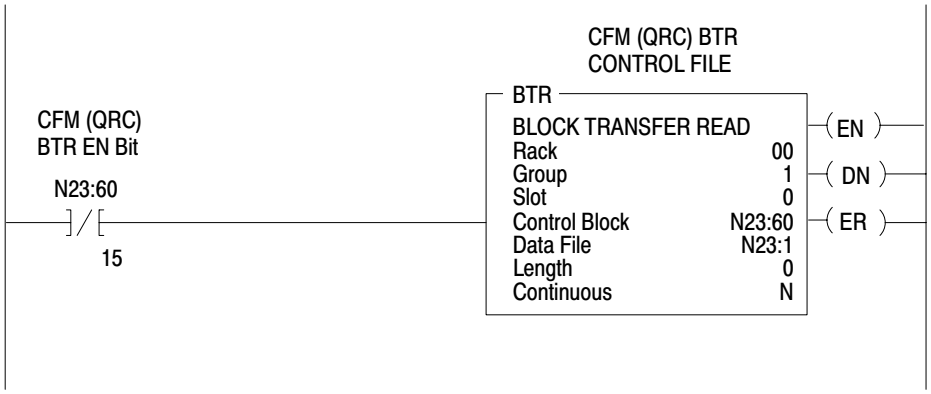
To initiate communication between the CFM module and your PLC processor, you must enter block transfer instructions into your ladder logic program. Enter the following rung to establish communication between the CFM module and your PLC processor.

PLC-5 Program Example

The CFM (QRC) module is located in rack 0, I/O group 1, slot 0. There are 3 words of data sent from the CFM (QRC) module to the PLC processor. This data is stored at N23:1. The BTR control file, starting at n23:60, is 5 words long.

Block transfer instructions use one binary file in a data table section for module location and other related data. The block transfer data file stores data that you want transferred from the CFM (QRC) module (when programming a BTR). The address of the block transfer data files are stored in the block transfer **control file.**

The programming terminal prompts you to create a control file when a block transfer instruction is being programmed. **A different block transfer control file is required for every module.**



Read Data From the CFM Module

When configured for QRC module emulation, BTR programming moves three words from the CFM module to the PLC processor's data table. **The following BTR assignments apply when the CFM module is configured for QRC module emulation.**

BTR Word	Bit															
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Block ID																
1	Header															
Input Channel Rate																
2	Rate of Ratemeter A															
3	Rate of Ratemeter B															
ALL numeric values are in binary																

BTR Word Descriptions

word 1

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1

Header will be 7001 Hex or 28,673 binary. Identifies the module as a CFM (QRC) module.

word 2 (ratemeter A)

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00

Rate — indicates the calculated rate.
RANGE: 0-15,800Hz binary

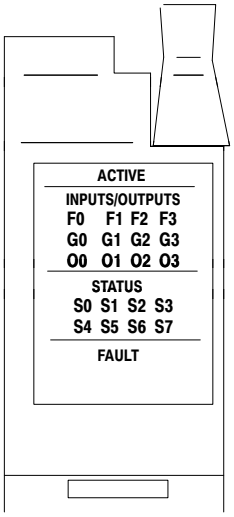
Rates: 0-169Hz are reported as zero
170-15,800Hz are reported as calculated
> 15,800Hz are reported as 15,800

The rates in words 2 & 3 are updated every 13.5ms-20ms maximum. The greater the frequency, the faster the update time. The accuracy of the returned rate is ±1Hz.

word 3 (ratemeter B)

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00

Interpret Status Indicators

Indicators	If indicator[1]	Is ON	Is OFF
	ACTIVE	the CFM module is receiving power and operational	**a.** Check FAULT LED — if on, follow the steps listed under if FAULT is ON. **b.** Check power supply LEDs.
	INPUTS (F0 & F2)	F0 – flashes with pulses at Channel A F2 – flashes with pulses at Channel B	a signal is not present at the designated input terminal (low)
	OUTPUTS[2] (O0 & O1)	O0 – indicates Channel A frequency is ≥ 15,800Hz O1 – indicates Channel B frequency is ≥ 15,800Hz	the output is off
	STATUS S3	BTR is occurring	BTR is not occurring
	FAULT	**1.** Turn off power to the I/O chassis backplane and wiring arm. **2.** Reseat the CFM (QRC) module in the I/O chassis. **3.** Restore power to the I/O chassis backplane and wiring arm. **Important:** If the fault LED remains on, there may be an internal problem. Contact your local Allen-Bradley representative for additional assistance.	normal operation

[1] All other LED's are OFF in normal operation.

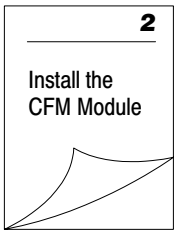
[2] Outputs are not active if PLC processor is faulted or in Program mode.

Additional Feature

When you replace your existing QRC module with the CFM module, you can set input channel jumpers for:

- TTL inputs (5-40v dc)
- 500mV ac sensitivity for improved noise immunity

For additional information on setting the input channel jumpers, see:



Replace Your QRD Module

What This Appendix Contains

Use this appendix to install the CFM module as a replacement for the QRD module.

Important: We assume that you are using a QRD module in your existing system and that you are familiar with the I/O module installation/removal procedures.

What the CFM Module Does

The CFM (QRD) module interfaces PLC processors with magnetic pickups, single channel shaft encoders, turbine flowmeters, or any source of TTL pulses.

When configured for QRD operation, the CFM (QRD) module calculates the frequency once per second, independent of the pulse edges.

The CFM (QRD) module is generally compatible with, but does not require the use of, turbine flowmeter signal preconditioning modules. It provides rate and count data in 2's complement binary format to the PLC processor's data table through block data transfers.

Rates as high as 10.0kHz and counts as large as 32,767 are supported. At overflow, the count continues from zero and an overflow flag is set. The overflow flag can be reset by the ladder logic. In addition, the PLC processor can reset any or all counts directly.

Important: Input frequencies > 30.0kHz may return unpredictable results in the BTR file.

Check Power Requirements

ATTENTION: The maximum current drawn by the CFM(QRD) module is **1.0A**. This current (1.0A) is 0.5A greater than the maximum current drawn by your QRD module (0.5A).

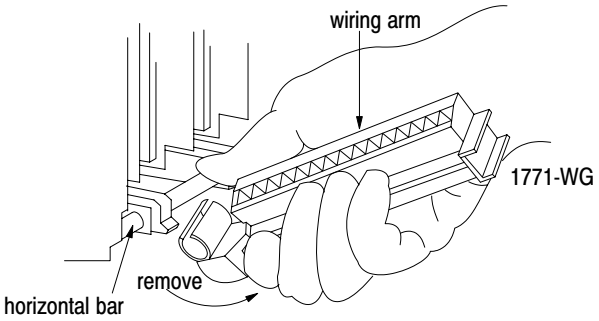
Consider the power usage of all modules in the I/O chassis to prevent overloading either the chassis backplane or power supply.

Remove Your QRD Module

ATTENTION: Remove power from the 1771 I/O chassis backplane and wiring arm before you remove your QRD module. Failure to remove power from the backplane could cause:

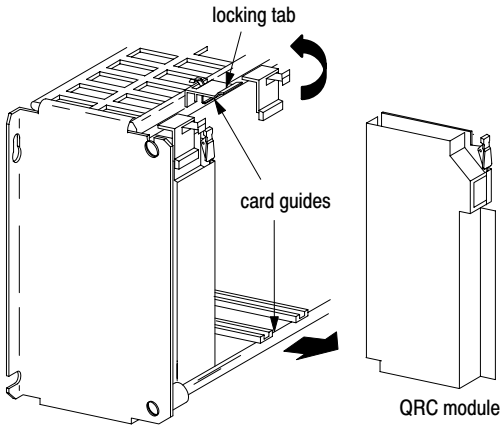
- injury
- equipment damage due to unexpected operation
- degradation of performance

1 Detach and remove wiring arm (1771-WG) from the horizontal bar at the bottom of the I/O chassis.

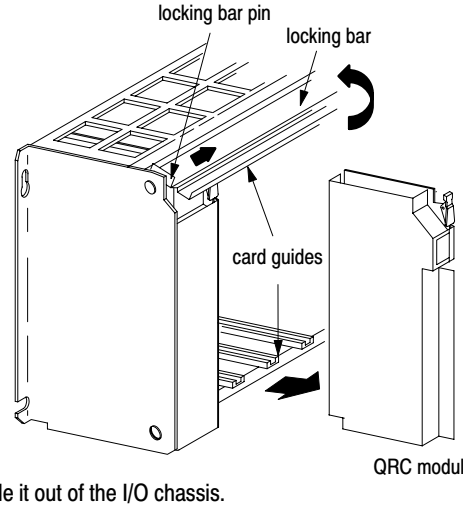


2 Remove the QRC module from the I/O chassis.

1771-A1B, -A2B, -A3B, -A3B1, -A4B I/O chassis



1771-A1B, -A2B, -A3B1, -A4B Series B I/O chassis



Pull on the QRC module to slide it out of the I/O chassis.

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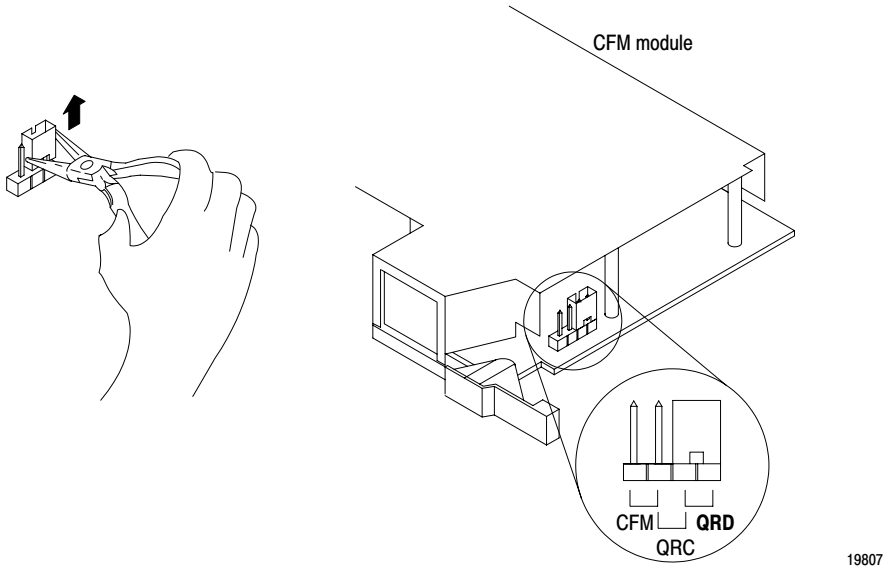
Set the Configuration Jumpers

You check and/or set these jumpers:

- module operation jumper
- input channel jumpers

Set the Module Operation Jumper

To use the CFM module as a replacement for a QRD module, set the operation jumper in the **QRD** position (default setting = **CFM** position).



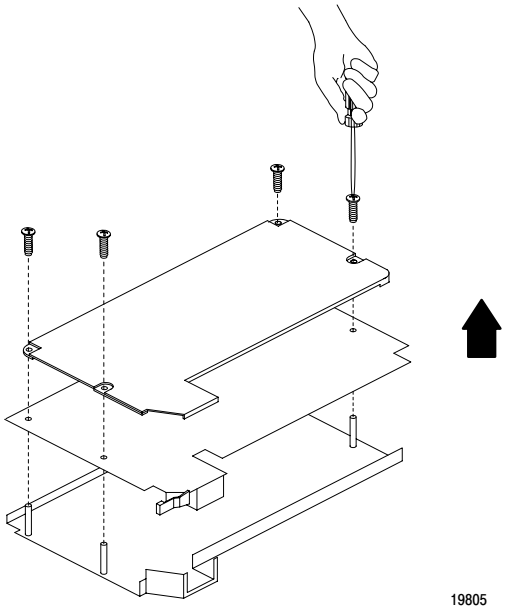
Check the Input Channel Jumpers

The CFM (QRD) module has user-selectable jumpers for each input channel. These jumpers consist of one each:

- flowmeter jumpers (F0–F3) - set for low-pass filter or high-speed operation
- gate jumpers (G0–G3) — set for +5-12V or +12-40V operation

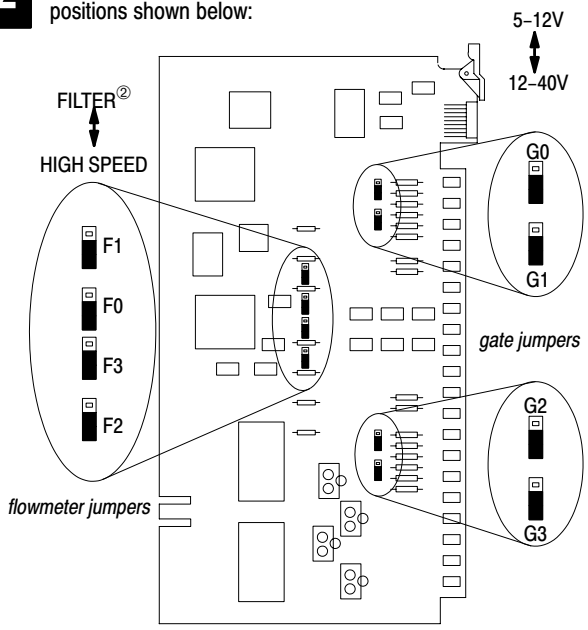
The CFM (QRD) module is configured for high-speed operation. Before installing your CFM (QRD) module, make sure the input channel jumpers are in their default positions.

1 Remove the four screws securing the side cover to the module and remove the covers.



19805

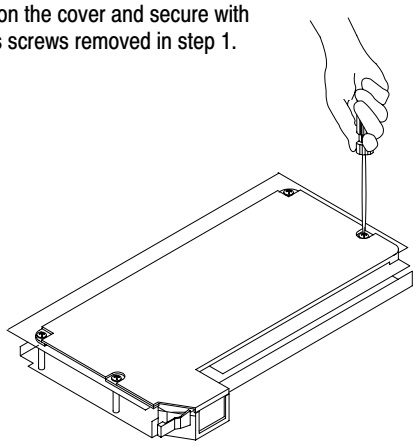
2 Make sure the input channel jumpers① are in the default positions shown below:



① Jumpers are shown in default settings.
② In the filter position, the module will not see frequencies above 70Hz.

19806

3 Reposition the cover and secure with the fours screws removed in step 1.



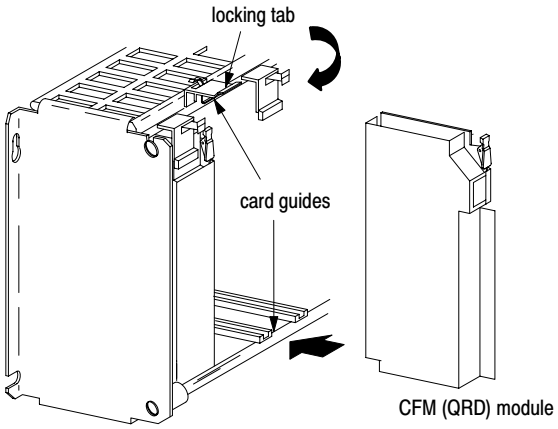
19813

Install the CFM Module

1 Place the CFM (QRD) module in the card guides on the top and bottom of the slot that guide the module into position.

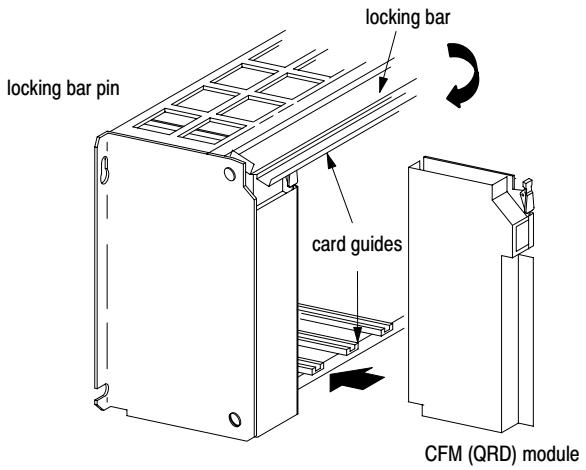
Important: Apply firm even pressure on the module to seat it into its backplane connector.

1771-A1B, -A2B, -A3B, -A3B1, -A4B I/O chassis



Snap the chassis latch over the top of the module to secure it.

1771-A1B, -A2B, -A3B1, -A4B Series B I/O chassis

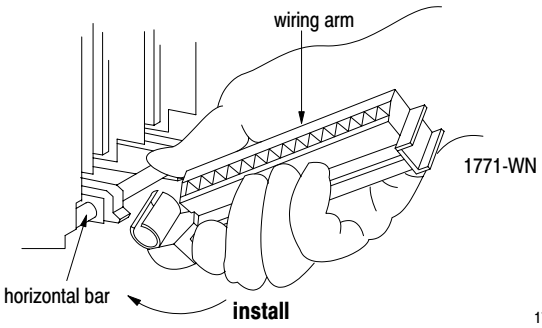


Swing the chassis locking bar down into place to secure the modules. Make sure the locking pins engage.

19809

2 Attach the wiring arm (1771-WN) to the horizontal bar at the bottom of the I/O chassis.

The wiring arm pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.

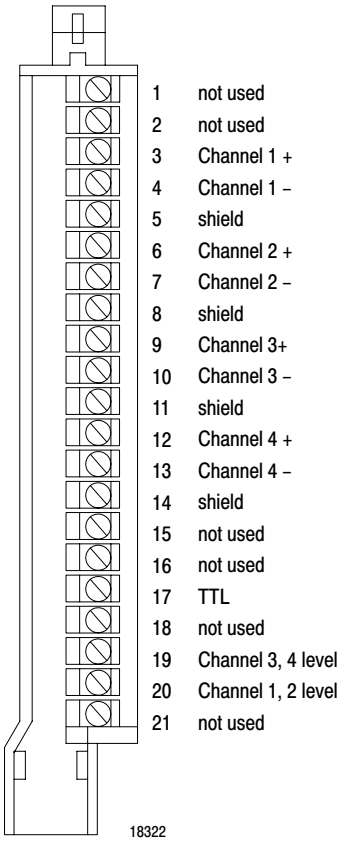


17643

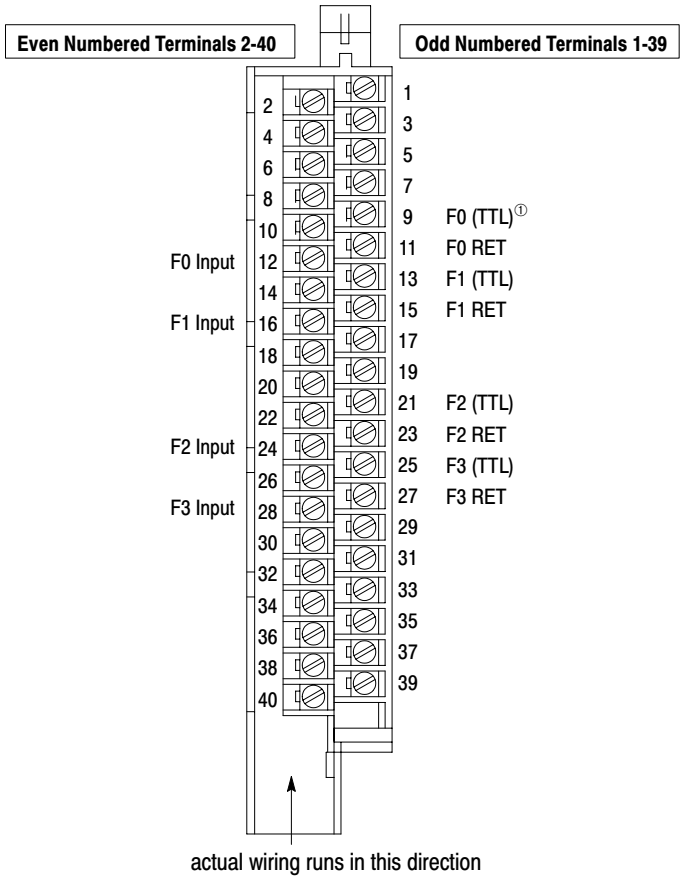
Make Connections to the New Wiring Arm

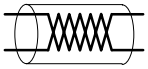
Connect your I/O devices to the 40-terminal field wiring arm (cat. no. 1771-WN) shipped with the CFM module. Use the wiring examples on page D–7 for additional assistance on connecting your devices.

OLD wiring arm (1771-WG)



NEW wiring arm (1771-WN)





The sensor cable must be shielded. The shield:

- must extend the length of the cable, but be connected only at the 1771 I/O chassis
- must extend up to the point of termination

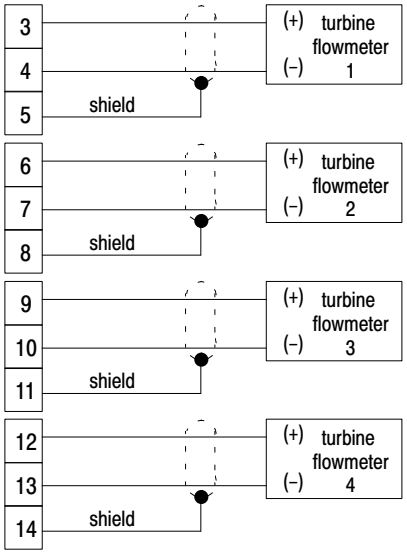
Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

① To use a channel in TTL, jumper the appropriate TTL pin to the appropriate RET. *To use Channel 1 in TTL, jumper pin 9 to pin 11.*

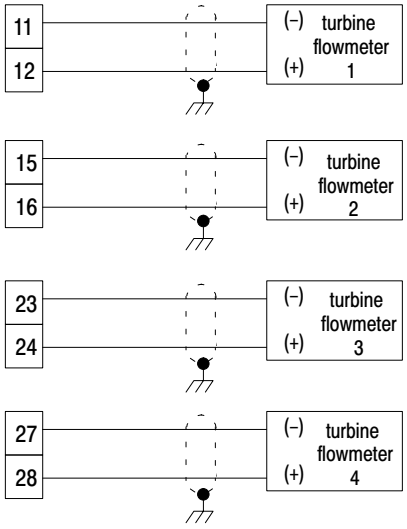
Wiring Examples

wiring for magnetic pickups or flowmeters

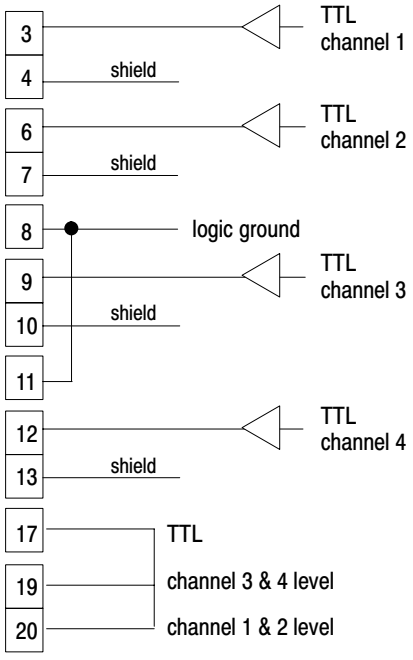
QRD module

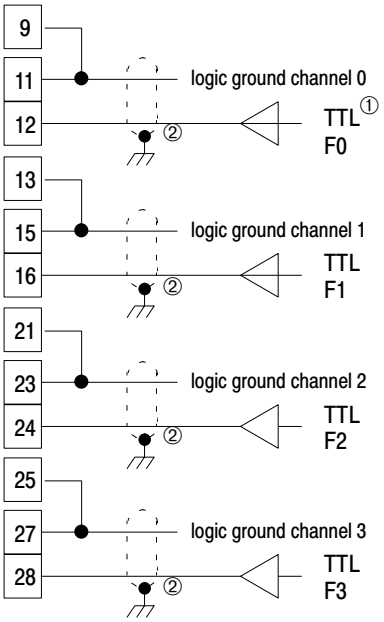


CFM module



wiring for active TTL drivers





① To use a channel in TTL, jumper the appropriate TTL pin to the appropriate RET.
To use Channel 1 in TTL, jumper pin 9 to pin 11.

Signal types can be mixed in any combination on the CFM module.

② For new installations, terminate the shields at the chassis. While not recommended, existing installations can continue to terminate the shields at the return (RET) terminal.

Resume Normal Operation

The CFM module, configured for QRD module emulation, operates as a QRD module. Use the following section for reference on how the CFM (QRD) module operates.

Edit Your Ladder Logic Program

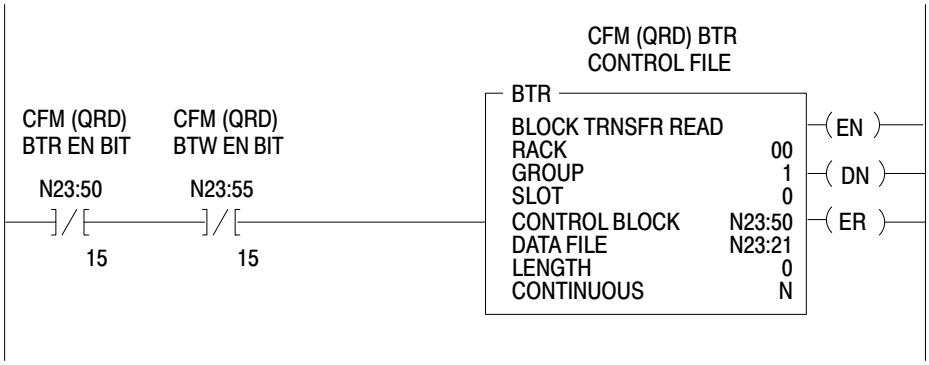
To initiate communication between the CFM (QRD) module and your PLC processor, you must enter block transfer instructions into your ladder logic program. The following program example illustrates the minimum programming required for this communication to take place.

Program Example

The CFM (QRD) module is located in rack 0, I/O group 1, slot 0. There are 9 words of data sent from the CFM (QRD) module to the PLC processor. This data is stored at N23:21. The BTR control file, starting at n23:50, is 5 words long.

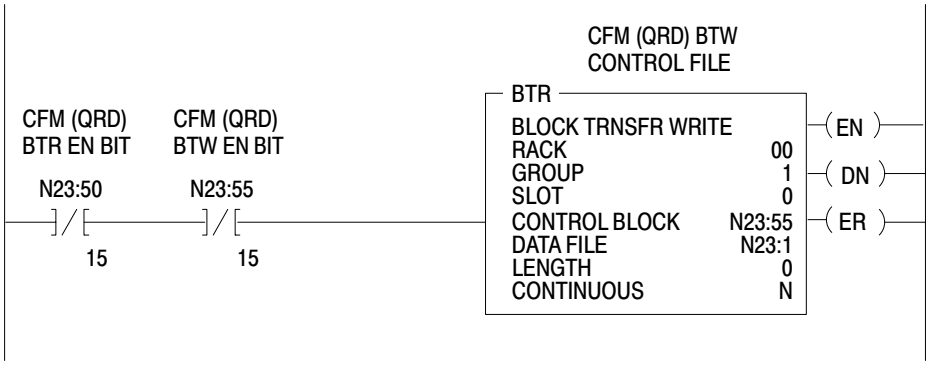
Block transfer instructions use one binary file in a data table section for module location and other related data. The block transfer data file stores data that you want transferred to the module (when programming a BTW) or from the module (when programming a BTR). The address of the block transfer data files are stored in the block transfer **control file.**

The programming terminal prompts you to create a control file when a block transfer instruction is being programmed. **A different block transfer control file is required for every module.**



The CFM (QRD) module is located in rack 0, module group 1, slot 0. There is 1 word of data sent from the PLC processor to the CFM (QRD) module. This data is stored at N23:1. The BTR control file, starting at n23:55, is 5 words long.

Note that the BTW is switch selectable, and its length is one word. The block transfer should only be sent once unless the ladder intelligently sets and clears the reset bits within the block transfer data. As an example, the ladder might set the reset bit at the time of overflow. If the block transfer is sent continuously and the reset bits contained within the block transfer data are simply left set to "1", the transfers will constantly be resetting the totalizer(s) and/or overflow flags of the specified channels.

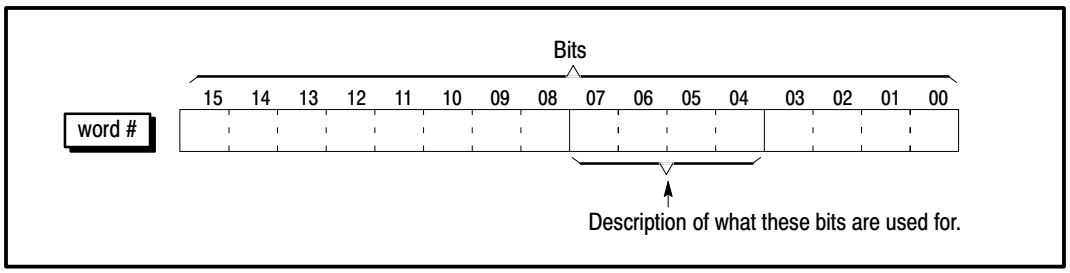


Read Data From the CFM Module

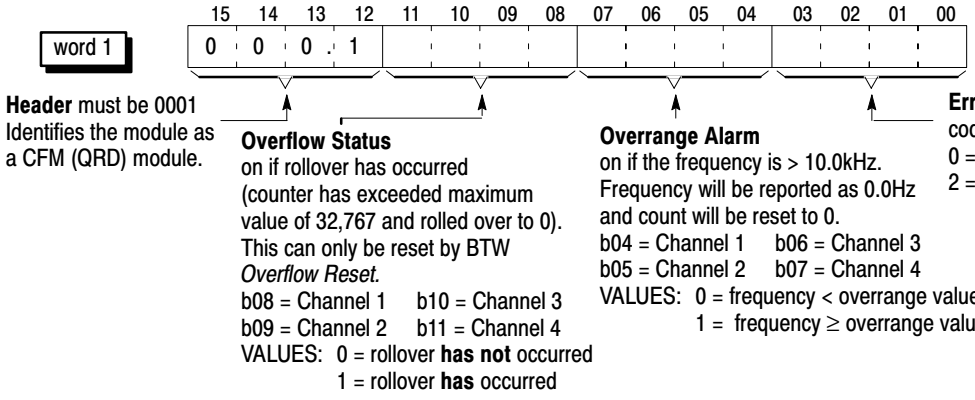
When configured for QRD module emulation, BTR programming moves nine words from the CFM module to the PLC processor's data table. **The following BTR assignments apply when the CFM module is configured for QRD module emulation.**

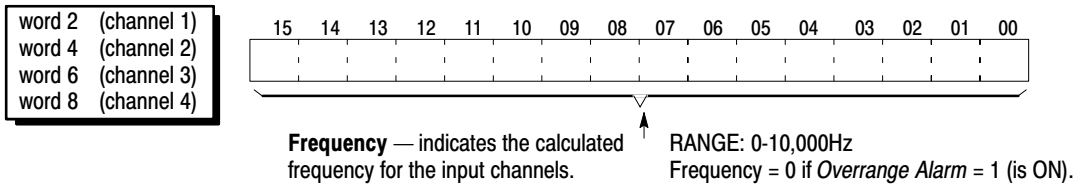
BTR Word	Bit															
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Block ID & Channel Status																
1	Header				Overflow Status				Overrange Alarm				Error Code			
Input Channel Data																
2	Frequency on Channel 1 (0-10,000)															
3	Total on Channel 1 (0-32,767)															
4	Frequency on Channel 2 (0-10,000)															
5	Total on Channel 2 (0-32,767)															
6	Frequency on Channel 3 (0-10,000)															
7	Total on Channel 3 (0-32,767)															
8	Frequency on Channel 4 (0-10,000)															
9	Total on Channel 4 (0-32,767)															
ALL numeric values are in binary																

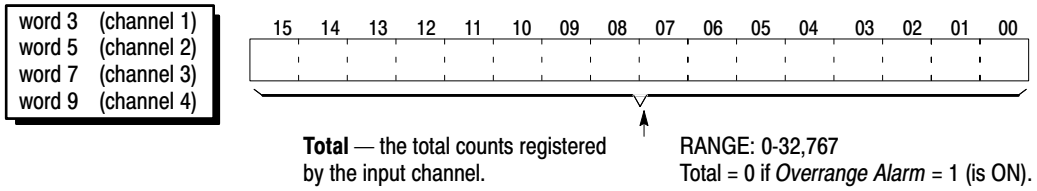
BTR Word Description Key



BTR Word Descriptions



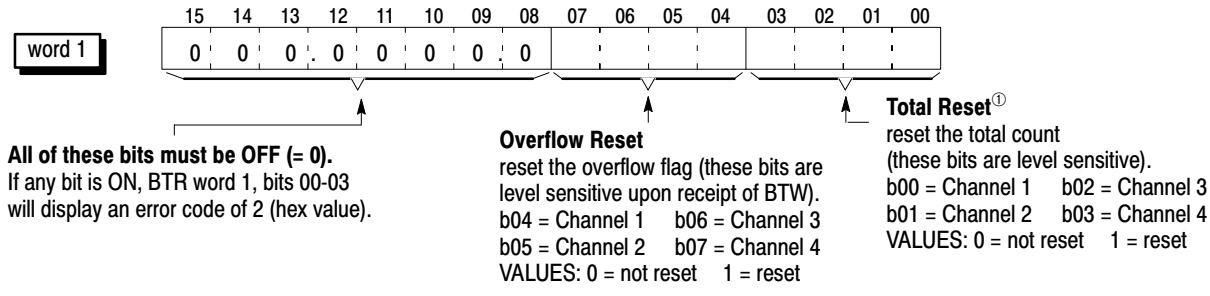




Reset Total and Overflow Flags

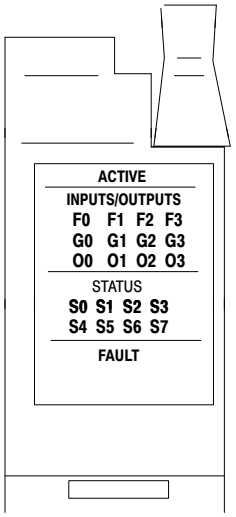
Any or all of the totalizers and overflow flags can be reset using a BTW command sent to the CFM module from the PLC processor. The BTW data word can be changed through the ladder logic, or by editing the data table.

BTW Word Description



① Resetting the total count will automatically reset its respective overflow flag(s). Continuously doing BTW's with *Total Reset* = 1 (reset) will affect the accuracy of the frequency.

Interpret Status Indicators

Indicators	If indicator[1]		Is ON	Is OFF
	ACTIVE		the CFM module is successfully receiving power and operational	**a.** Check FAULT LED — if on, follow the steps listed under if FAULT is ON. **b.** Check power supply.
	INPUTS (F0 - F3)		F0 – flashes with pulses at Channel 1 F1 – flashes with pulses at Channel 2 F2 – flashes with pulses at Channel 3 F3 – flashes with pulses at Channel 4	a signal is not present at the designated input terminal
	STATUS	S1	BTW invalid (BTW word 1, bits 08-15) ≠ 0	BTW is valid
		S2	BTW is occurring	BTW is not occurring
		S3	BTR is occurring	BTR is not occurring
		S4	frequency > 10.0kHz (overrange) **on any channel**	all frequencies within operating range
	FAULT		**1.** Turn off power to the I/O chassis backplane and wiring arm. **2.** Reseat the CFM module in the I/O chassis. **3.** Restore power to the I/O chassis backplane and wiring arm. **Important:** If the fault LED remains on, there may be an internal problem. Contact your local Allen-Bradley representative for additional assistance.	normal operation

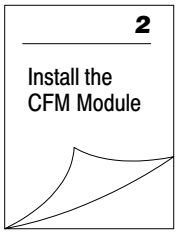
[1] All other LED's are OFF in normal operation.

Additional Feature

When you replace your existing QRD module with the CFM module, you can set input channel jumpers for:

- 500mV ac sensitivity for improved noise immunity
- frequencies > 70Hz (flowmeter filter jumpers)

For additional information on setting the input channel jumpers, see:



Using I/O Configuration Software

What This Appendix Contains

Use this appendix along with the *PLC-5 Programming Software, I/O Configuration Software* manual (publication 6200-6.4.12) to configure the CFM module using I/O Configuration software.

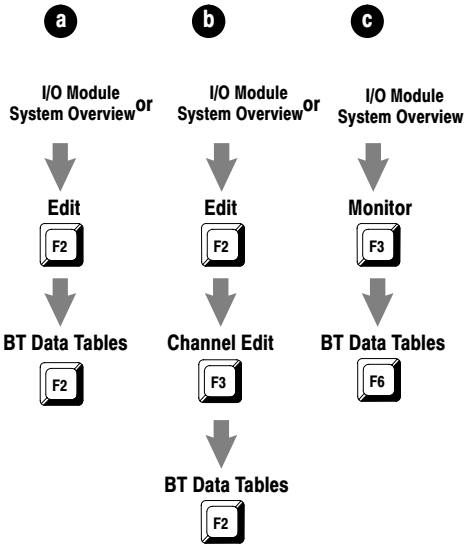
Configure the CFM Module

To configure the CFM module, you use these screens:

- Block Transfer Data screen
- Channel Setup screen
- Output Setup screen
- Monitor screen

Block Transfer Data Screen

Use the Block Transfer Data screen to display an image of the PLC processor data tables for the CFM module.



You cannot edit the information on this screen.

```
1771-CFM Series A          Block Transfer Data          Rack-Group-Module: 0-0-0

Configuration Data (BTW)                  Input Data/Status (BTR)

  N7:10       12032  17425  12561   8451 -28572       N7:100       8192  16384
                                                      N7:102       8451      0
  N7:15          10      0  15000   2000      0       N7:104      21712     23
                                                      N7:106          0    430
  N7:20           0      0      0      0      0       N7:108          0      0
                                                      N7:110          0      0
  N7:25           0      0      0      0      0       N7:112          0      0
                                                      N7:114          0      0
  N7:30           0      0      0      0   2048       N7:116          0      0
                                                      N7:118          0      0
  N7:35        1000      0      0   5000      0       N7:120          0      0
                                                      N7:122          0   4232
  N7:40           1      2      0      0      0       N7:124          1   5499
                                                      N7:126        446   4049

Press arrow keys or PgUp/PgDn to see more data.

Rem RUN                                          mod 1 of 1      Addr#42:CFM4B
Change    I/O   Channel Output  Monitor Change  Display
 Mode   Ovrview  Setup   Setup           Radix  Symbols
  F1      F2      F3      F4      F5      F6      F7
```

Channel Setup Screen

Shows **current values** for each channel (these values reflect the data received the last time a BTR was completed).

The PLC processor *must be* in Run mode if you want to receive current data from the CFM module.

Shows **current programming** for each channel and lets you change the channel programming.

Fields inapplicable in the programmed channel mode are shown as dashes and *cannot* be edited.

```
1771-CFM Series A              Channel Setup              Rack-Group-Module: 0-0-0
                        channel    0   channel    1   channel    2   channel    3
current values:
  channel mode         high-res freq     (not used)      totalizer  noreset totzr
  frequency                    43.0                         15,487           258
  total counts                  ---                      3,881,128     1,111,111
  acceleration                    0                            359             0
--------------------  channel    0   channel    1   channel    2   channel    3
new channel mode       high-res freq     (not used)      totalizer  noreset totzr

minimum sample time           10 ms                        1000 ms     0 = 100 ms
  for frequency
acceleration                 2,000                         5,000       disabled
  alarm value
accel sample time              100                    rolling avg            ---
  (freq intervals)
highest allowed             60,000                             0             0
  frequency

Press F9(Toggle) to change channel mode.

Rem RUN                                          mod 1 of 1      Addr#42:CFM4B
Change    I/O           Output  Monitor BT Data          Default Toggle  Accept
 Mode   Ovrview          Setup           Tables           Config
  F1      F2              F4      F5      F6               F8      F9      F10
```

```
  --------------------  channel    0   channel    1   channel    2   channel    3
  lowest measurable             1 Hz                          ---            ---
    frequency
  end sample on             time only                         ---            ---
  counts to end                  ---                          ---            ---
    sampling
  frequency resolution         0.1 Hz                         ---            ---
  frequency scalers              1/1                          1/1           1/60
    (multiply/divide)

  Press F9(Toggle) to change bandwidth limit.

  Rem RUN                                        mod 1 of 1      Addr#42:CFM4B
  Change    I/O           Output  Monitor BT Data          Default Toggle  Accept
   Mode   Ovrview          Setup           Tables           Config
    F1      F2              F4      F5      F6               F8      F9      F10
```

```
    --------------------  channel    0   channel    1   channel    2   channel    3
    scalers for total              ---                          1/2            1/1
      (multiply/divide)
    rollover value                 ---                            0      5,000,000
    tied to outputs              0,2,3                            1           none
    reset total                    ---                     disabled            ---
    reset overflow                 ---                     disabled       disabled
    start prover                   ---                      enabled        enabled
    prover type, uni               ---                           bi            uni
      or bidirectional

    Enter rollover value (0 to 9,999,999).
    >
    Rem RUN                                          mod 1 of 1      Addr#42:CFM4B
    Change    I/O           Output  Monitor BT Data          Default         Accept
     Mode   Ovrview          Setup           Tables           Config
      F1      F2              F4      F5      F6               F8              F10
```

Choose one:

- **a** — I/O Module System Overview → **Edit** (F2)
- **b** — Output Setup or Monitor or BT Data → **Channel Setup** (F3)
- **c** — Ladder Editor Main Menu → Cursor to BT instruction → **Edit** (F10) → **I/O Edit** (F2)

Use PageUp or PageDown to move through the channel setup screens.

Press **(F3) - Channel Setup** to configure individual channels or **(F10) – Accept** to accept your edits. We suggest that you complete your edits on all screens before accepting the edits.

Current values	Displays	In mode(s)
channel mode	the current channel mode as returned in the BTR data file by the module	all
frequency	the current scaled frequency	all
total counts	the scaled total counts	T, NRT
acceleration	if acceleration alarm value ≠ 0, value = the acceleration (change in scaled frequency per second) = 0, value = 0	all

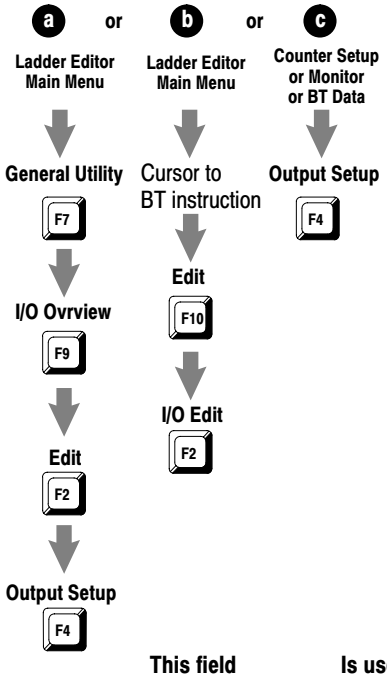
Current programming	You	In mode(s)
new channel mode	press (F9) - Toggle to select a mode of operation for the input channel: › not used › totalizer › noreset totzr (nonresettable totalizer) › high-res freq (high-resolution frequency) › direction (direction sensor) **Important:** The High-resolution frequency and Direction Sensor modes each occupy two channels and are selected via channel 0 (channel 1 unused) or channel 2 (channel 3 unused).	all
minimum sample time for frequency	enter the minimum time value the CFM module will spend to determine frequency RANGE: 4–1000ms (0-3 = DEFAULT) DEFAULT (if you enter 0): 100ms (T, NRT) 4ms (HR, DS) In Direction Sensor, this time is used to determine the maximum sample time and minimum frequency and does not actually determine the time period.	T, NRT, HR
acceleration alarm value	enter an alarm value of 0 to 32,767 DEFAULT (if you enter 0): all acceleration features of the module are disabled	all
accel sample time (freq intervals)	*only when the acceleration alarm value ≠ 0* enter a number to determine how many frequency intervals (1 to 750) should be spanned in computing acceleration DEFAULT (if you enter 0): acceleration calculated as rolling average over 5 samples	T, NRT, HR
highest allowed frequency	enter a value up to 120,000Hz for the overspeed threshold DEFAULT (if you enter 0): 120,000Hz The highest allowed frequency is in Hz, not in scaled frequency units. For example, if you select 120,000Hz as the highest allowed frequency and select frequency scalers of 1/60, the module sets the overspeed bit in the BTR for any scaled frequency above 2000 (120,000Hz).	T, NRT, HR
lowest measurable frequency	press (F9) - Toggle to select 1 Hz (full frequency range, 1 Hz to 100kHz) or 1/sample time — this field = *Bandwidth Limit* in BTW configuration block	HR
end sample on	press (F9) - Toggle to select time only or time/counts (time only means when the minimum sampling time has elapsed and at least one count has been received) — this field = *Terminate Enable* in BTW configuration block	HR
counts to end sampling	enter the number of counts (0-32,767) to end sampling on	HR
frequency resolution	select the precision of the frequency (1Hz or 0.1Hz) returned in the BTR (if you have scaling programmed for frequency, the resolution will be in whole numbers of tenths of scaled frequency units)	HR
frequency scalers (multiply/divide)	enter a multiplier and divisor separated by a (/) to have the module report frequency in units meaningful to your application **(the multiplier must be ≤ the divisor)** RANGE: 1-255 DEFAULT: 1/1 (no scaling) For example, if one count represents 7 gallons, you could scale frequency to gallons per minute by entering scalers of 7/60. *Scaling affects only the frequency and acceleration value that the module returns in the BTR. All programming in the BTW -- e.g. highest allowed frequency, output ON and OFF values still in Hz.*	all

Mode abbreviations:
Totalizer = T Nonresettable Totalizer = NRT High-resolution Frequency = HR Direction Sensor = DS

Current programming	You	In mode(s)
scalers for total (multiply/divide)	enter a multiplier and divisor here, separated by a (/) to have the module report total counts in units meaningful to your application **(the multiplier must be ≤ the divisor)** RANGE: 0-32,767 DEFAULT: 1/1 (no scaling) For example, if 15 counts represent 2 gallons, you could scale counts to gallons by entering scalers of 2/15. *Scaling affects only the total counts value that the module returns in the BTR. All programming in the BTW -- e.g. rollover value, output ON and OFF values is still in Hz .*	T, NRT
rollover value	enter a count value that the totalizer will reset or rollover to 0 at (when the unscaled count reaches that value, the module sets the overflow status bit in the BTR and starts counting again from 0) RANGE: 0–9,999,999 DEFAULT (if you enter 0): 10,000,000	T, NRT
tied to outputs	see the output(s) that are currently tied to this input channel (*this field is display only* — to tie outputs to a different input channel, use the Output Setup screen.	all
reset total	see if the Total Reset (BTW word 1, bits 00-30) is ON (*this field is display only*).	T
reset overflow	see if the Overflow Reset (BTW word 1, bits 04-07) is ON (*this field is display only*).	T, NRT
start prover	see the current settings in the BTW data file (you must make any changes to this field through a running program on the PLC processor, or by directly setting bits in the BTW; *you can not edit these fields with the I/O Configuration software)*	T, NRT
prover type, uni or bidirectional	press (F9) - Toggle to select the type of prover you are using in your application 0 = unidirectional 1 = bidirectional.	T, NRT

Mode abbreviations:
Totalizer = T Nonresettable Totalizer = NRT High-resolution Frequency = HR Direction Sensor = DS

Choose one:



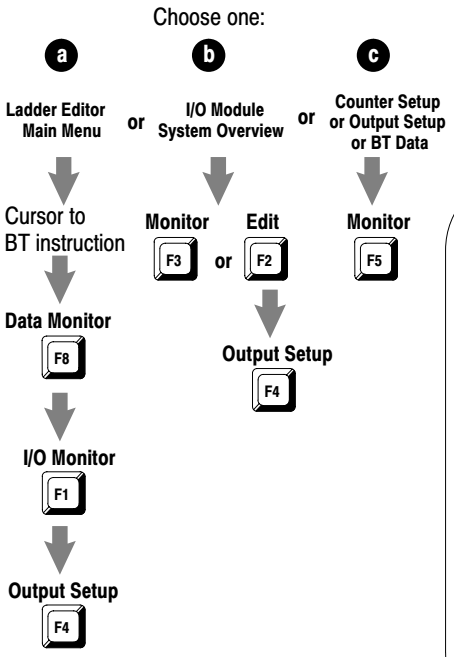
Output Setup Screen

```
1771-CFM Series A              Output Setup                Rack-Group-Module:
0-0-0

     output  current  tied to    forced or
     number  status   channel   triggered by      ON when >=    OFF when >=

       0       off      0      rate/frequency          1,000         25,000

       1       off      2      total                       0      3,500,000

       2       on       0      rate/frequency              0         12,000

       3       off      0      acceleration              100              0

Enter numeric trigger value, or press F9 to change direction trigger.
>
Rem RUN                                          mod 1 of 1      Addr#42:CFM4B
Change    I/O   Channel         Monitor BT Data          Default          Accept
 Mode   Ovrview  Setup                 Tables           Config
  F1      F2      F3              F5      F6              F8              F10
```

Press **(F4) - Output Setup** for other configuration choices or **(F10) – Accept** to accept your edits. We suggest that you complete your edits on all screens before accepting the edits.

This field	Is used to
output number	display the output numbers (0-3)
current status	display each output's current status (ON or OFF) — these values reflect the data received the last time a BTR was completed (*the PLC processor must be in Run mode if you want to receive current data from the CFM module*)
tied to channel	select the input channels (0-3) that the output channel is tied to (default is None) — Press (F9) – Toggle to select number
forced or triggered by	select what channel characteristic the output is triggered ON or OFF by (the default is disabled) — press (F9) - Toggle to select one of these characteristics: **Disabled**: always forces the output to an OFF state. If you select Disabled, you cannot tie the output to a channel, and you cannot enter ON/OFF values. **Rate/Frequency**: specify ON and OFF values in Hz, not in scaled frequency units. **% of Full Scale**: specify ON and OFF values as percentages of the channel's highest allowable frequency from the Channel Setup screen. T, NRT, HR **Acceleration**: channel's alarm must be nonzero. Specify ON and OFF values of –32,768 to 32,767 Hz/s, representing a change per second in unscaled frequency. all **Total**: Specify ON and OFF values in unscaled counts from 0 to 9,999,999. If the channel has a nonzero rollover value programmed, the ON and OFF values must be less than the rollover. T, NRT **Direction**: For ON and OFF values, press (F9) - Toggle to select stop, CW (clockwise), or CCW (counterclockwise). DS **Overflow**: If you specify this mode, you must tie the output to a channel, and that channel's mode must be totalizer or nonresettable totalizer. You cannot enter ON and OFF values. The output will be ON when the overflow bit is set in the BTR, and OFF when the overflow bit is clear. **Forced On**: If you specify this mode, you cannot tie the output to a channel or enter ON and OFF values. **Prover running**: You cannot enter ON and OFF values. The output will be ON during a prover run and OFF at other times. T, NRT **Prover range**: For ON and OFF values, press (F9) - Toggle to select from these prover values prover not selected prover selected but not running in rev (reverse) leg in fwd (forward) leg fwd leg done done If the channel's prover type of the Channel Setup screen is unidirectional, "fwd leg done" and "in rev leg" are not valid settings for ON and OFF values. T, NRT
ON when >= OFF when >=	Enter a value between 0 and 9,999,999. The output state transitions from an OFF state to an ON state when the monitored value exceeds the ON count. The output state transitions from an ON state to an OFF state when the monitored value exceeds OFF.

Monitor Screen



Use the monitor screen to check and verify the configuration data. The values on this screen reflect the data received the last time a BTR was completed. **The processor must be in Run mode if you want to receive current data from the module**.

```
1771-CFM Series A                Monitor                Rack-Group-Module: 0-0-0

ch  ------ frequency -------    total   acceleration  prover total/  alarms (*)
              % full scale                            stored count
 0       43.0    .07 (   23)                    0                          ---
 1                                                                          ---
 2     15,498  12.91 ( 4231)   4,349,126        0               0         ---
 3        258  12.92 ( 4233)   2,047,108        0               0           OF
        (*)  AC=acceleration  SP=overspeed  OF=overflow  OR=overrange

ch          mode              direction     prover    | output  current  tied to
                                            status    | number  status   channel
 0  high-resolution frequency                         |   0       off       0
 1  (not used)                                        |   1       off       2
 2  totalizer                              done       |   2       on        0
 3  nonresettable totalizer                done       |   3       off       0
Has module received valid BTW since powerup? yes             BTW error code: none

Press a function key.

Rem RUN                                          mod 1 of 1      Addr#42:CFM4B
Change    I/O   Channel Output          BT Data
 Mode   Ovrview  Setup   Setup          Tables
  F1      F2      F3      F4              F6
```

This field	Displays
`ch`	the input channel (0 to 3).
`frequency`	the frequency in Hz and % full scale
`total`	scaled total counts, using scaling from the Channel Setup screen [T, NRT]
`acceleration`	the acceleration as a change per second in scaled frequency [all]
`prover total/ stored count`	the stored count or Prover run result [T, NRT]
`alarms`	the alarm activated (SP=overspeed, AC=acceleration, OF=overflow, OR=overrange)
`mode`	input channel's current mode of operation
`direction`	the direction of rotation CW (clockwise) or CCW (counterclockwise) [DS]
`prover status`	prover status [T, NRT]
`output number`	the output channel (0 to 3)
`current status`	the state of the current output (ON or OFF) — these values reflect the data received the last time a BTR was completed (**the PLC processor must be in Run mode if you want to receive current data from the CFM module)**
`tied to channel`	which input channel the output is tied to
`module power-up`	whether a BTW has successfully occurred since power-up (YES or NO)
`BTW error code`	an error code is (If an error occurred in the last BTW) — error codes 1 to 60 are word numbers where invalid configuration was programmed in the BTW data file

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Cat. No. **1771-CFM/B** Pub. No. **1771-6.5.99** Pub. Date **November 1995** Part No. **955122-98**

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