Diverter Driver Option

Operation Theory And Application Notes

Rev. March 2003

General Description

IDX Xeptors can be ordered with a built-in Diverter Driver (see How To Order page in the manual) to control an external coin diverter for the purpose of sorting the end destination of two classes of accepted coins. There are two primary situations calling for this capability. First, one may wish to accept multiple denominations, and direct only one to a change hopper, and the others to a vault drop. Second, one may wish to accept a promotional token in addition to the usual coin, but always have the promotional token diverted to the vault drop. The Diverter Driver works in tandem with existing controls for the "hopper full" diverter without the need for formal communication or software changes in the host machine.

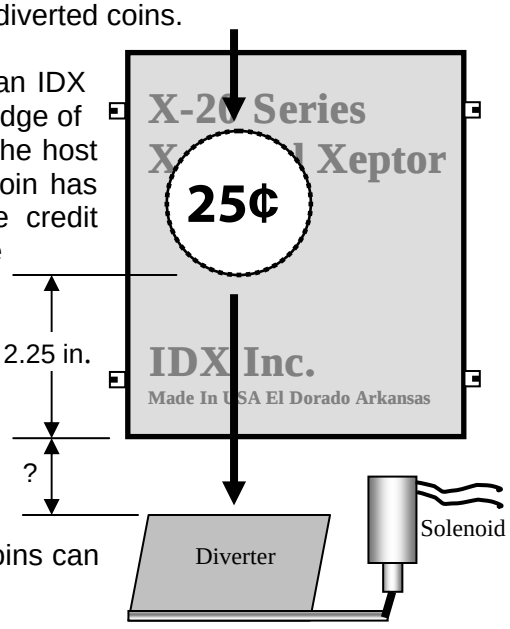
Diverter Driver Features

- Optically coupled AC/DC FET circuit switches up to 400mA, 60V, AC/DC.
- Output FET device is snubber protected from inductive load fly back spikes.
- Diagnostic green LED indicator shows when Xeptor activates Diverter Driver.
- Two-wire connection into diverter solenoid circuit. (see installation notes below)

Theory Of Operation

The figure below depicts a coin passing through a coin acceptor with a diverter mechanism located beneath it. The diverter mechanism traditionally directs accepted coins to the payout hopper until it is filled, and then is controlled by the machine processor to direct coins to the drop vault. When it is desired to additionally accept a second type of coin, such as a second denomination or a promotional token, the second coin generally must always be diverted to the drop vault to prevent having multiple denominations or multiple size coins in the payout hopper. In order to successfully accomplish this task a) the diverter must be controlled on a coin-by-coin basis, b) the diverter mechanism must be suitable for real time diverter control, and c) there must be separate identification and accounting of the specially diverted coins.

a) Coin-By-Coin Control. When the coin is passing through an IDX Xeptor, the Xeptor knows the coin's identity when the leading edge of the coin is 2.25 inches from the bottom of the unit. However, the host machine may typically not know the coin's identity until the coin has fully passed through the Xeptor and been validated by the credit sensors of either the Xeptor or the host machine. By this time the coin is already entering the diverter, or is so close to the diverter that it is too late for the host machine to move the diverter to the other position. Therefore, coin-by-coin diverter control must be provided by the Xeptor and must work in tandem with the existing diverter control signals of the host machine. (See Electrical Interface section below.)



b) Suitable Diverter Mechanism. The diverter mechanism must be able to move fast enough to sort coins in real time. Coins can

be fast fed by a practiced player at as many as10 coins per second. To be able to separate a stream of these coins reasonably reliably, the diverter mechanism should be able to move from one side to the other, in each direction, in less than ½ of 1/10th of a second, which is less than 50ms. If the speed of the diverter mechanism is unknown, it can easily be measured by a technician using pulse generator to produce first a positive going narrow pulse, then a negative going narrow pulse to drive the transistor that currently drives the diverter solenoid.

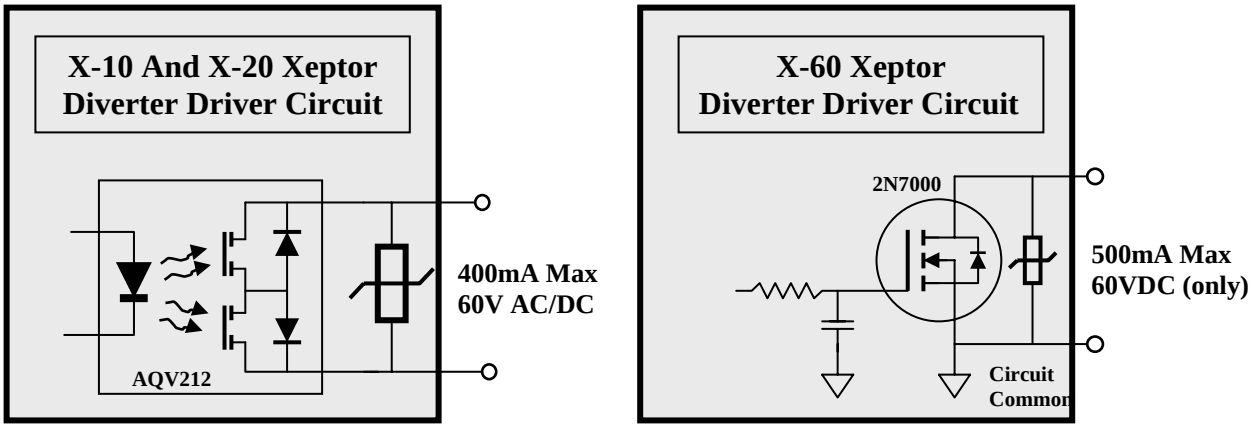
A second further requirement is that the time available for the leading edge of the coin to get to the diverter has to be less than the diverter activation time. This will depend on how far below the diverter is from the bottom of the coin acceptor. Newtonian mechanics teaches us that the velocity $v = \sqrt{2ax}$ and that the average speed of the falling coin after 6 inches of travel is nearly 70 in/sec. If the diverter is 0.15 inches below the coin acceptor, the coin must travel 2.4 inches before it gets to the diverter, which is traveled in 2.4/70 = 34ms. If the diverter is 1.25 inches below the coin acceptor, then there is 3.5/70 = 50ms to move it.

c) Separate Identification. Normally separate counts of coins sent to the hopper and coins sent to the drop must be tallied. There are two methods by which the host machine can get this information. The first and most direct method is to read the logical state of the voltage on the diverter solenoid at the time each coin is being credited. The second method is to have the coin acceptor provide different signals for each of the two coins to be accepted. IDX Xeptors have the capability of producing a 3 bit binary code for identification of the coin accepted. Via selection of a particular Personality Plug (electrical interface), the code can be used directly as a binary code, or expanded into one-of-seven individual outputs. For more details see the sections below on NRI Emulation and Personality Plugs.

Xeptor Diverter Driver Circuits

X-10 and X-20 Circuits. The diverter driver circuit for the X-10 and X-20 consists of an optically coupled back-to-back FET capable of switching up to 400mA, 60V AC or DC. The output is snubber protected by a 47V MOV. The optically coupled design allows the output terminals to be connected in virtually any type of diverter driver circuit, including ground referenced and power referenced connections. A small green indicator LED on Xeptor circuit board indicates when the diverter driver output is switched on.

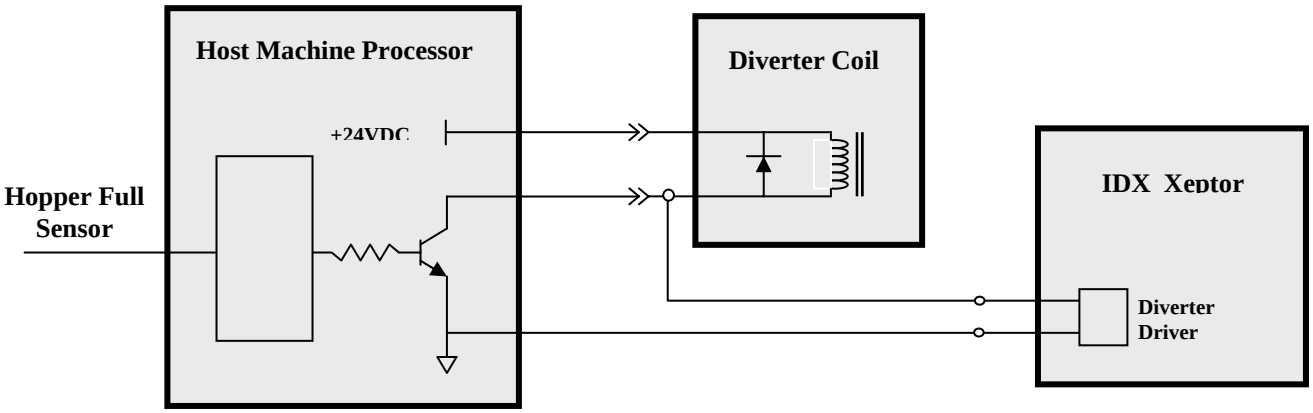
X-60 Circuit. The diverter driver circuit for the X-60 is a MOV protected, ground referenced, NMOS FET capable of driving up to 500mA @ 60VDC. Unlike the circuits for the X-10 and X-20, it may only be used in a ground referenced switching configuration. The X-60 has no indicator LED for the diverter.



Diverter Driver Connection / Logic

To The Drop Vault For Activate Diverter: Most host machines have a sensor that detects the hopper fill condition. The sensor signal is provided to the machine processor, which filters the often-erratic signal and controls an NPN Darlington transistor to activate the diverter coil. The necessary logic for this connection, as shown in the table to the right, is an "OR" connection such that either the host machine or the Xeptor can independently activate the diverter to send the coin to the drop vault. The block diagram below shows how to connect the Xeptor Diverter Driver into the machine circuitry to implement what is called a wired-OR control circuit. Remember, coins programmed in Coin Memories 4-6 are diverted.

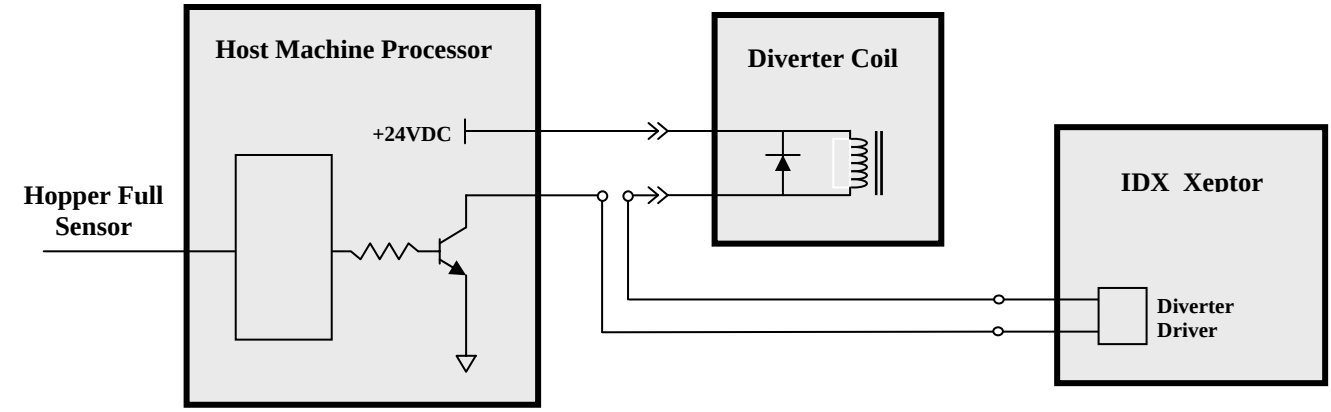
	Hopper Coin	Drop Coin
Hopper Full	Divert	Divert
Hopper Empty	-----	Divert



Example Connection For: Active Diverter Sends Coin To Drop Vault.

To The Hopper For Activate Diverter: Some host machines do things just the opposite; the diverter is active when the coin is to go to the payout hopper. The table at the right shows the "AND" logic required so that either the host machine or the Xeptor can turn off the diverter coil independently to send the coin to the drop vault. While the wired-OR circuit above puts the switching devices in parallel, the wired-AND circuit below puts the switching devices in series. When in series, either device can turn off the diverter coil, but it takes both of them to turn it on. In this case, coins in Coin Memories 4-6 will go to the hopper.

	Hopper Coin	Drop Coin
Hopper Full	----	----
Hopper Empty	Divert	----



Example Connection For: Active Diverter Sends Coin To Hopper.

Diverter Pulse Timing

The Xeptor Diverter Driver output pulse timing sequence is triggered at the point when the coin's leading edge is 2.25 inches from the bottom of the Xeptor, as show on an earlier page. The pulse timing sequence includes **Divert_Delay and Divert_Pulse values,** which are programmed into the Xeptor using the "P" command and "S" command (see Serial Port Protocol in manual). Starting at the trigger point, there is a delay of Divert_Delay milliseconds before the start of the output pulse of duration Divert_Pulse milliseconds.

The values for Divert_Delay and Divert_Pulse are chosen so that the diverter flapper is reliably in position by the time the coin reaches it, but no sooner than is really necessary. If the diverter flapper is moved too quickly, it could interfere with the path of a coin in front of it that is not supposed to be diverted.

1. **Divert_Delay** should be lengthened until coins to be diverted are no longer diverted reliably, then reduce Divert_Delay by about 8ms (about 1/2 inch of coin travel). This provides some margin for reliability, particularly if the flapper had momentum in the other direction due to a prior coin.
2. **Divert_Pulse** should normally be at least 16ms (about 1 inch of coin travel) longer than the diverter activation time, or about 8ms more than lowest reliable value Divert_Pulse. If it gets too short, then some coins will not be diverted, particularly if they are falling a little slower than most coins. Increasing Divert_Pulse to some very large value will normally work well because a following coin that is not to be diverted will commandeer the timer for its own needs. However, if the deactivation time of the diverter is much longer than the activation time, it will be important to keep the Divert_Pulse as reasonably short as possible because a tailgating coin that should not be diverted may well slip through the wrong path because the diverter mechanism is too slow in the deactivation direction.

Test The Parameters for reliable behavior by doing the following:

1. Single feed numerous of each of the two types of coins.
2. Fast feed groups of the coin to be diverted.
3. Fast feed mixed groups of coins.

Diverter Electromechanical Response. As you have probably wisely surmised, the timing parameters for Divert_Delay and Divert_Pulse will depend both on the electromechanical response time of the diverter mechanism, and on the position of the diverter mechanism below the coin acceptor. Although most existing machine diverter mechanisms activate and deactivate in about 40ms, some have been clocked at 25ms to activate and over 80ms to deactivate. This asymmetrical behavior is easily improved by strengthening the return spring. Symmetrical behavior is important for reliability in separation when one type of coin closely follows the other, and the same Divert_Delay and Divert_Pulse values apply to either sequence of coins.

The activation and deactivation time of the diverter can be measured by simply using a pulse generator to drive a transistor that activates the diverter. A 20% duty factor high going pulse and a 20% duty factor low going pulse, respectively, are adjusted in width until the diverter is just barely making the transition back and forth. The pulse width, in each case, reflects the respective activation or deactivation time of the diverter mechanism.

Firmware Revision Note: Xeptor processor chips dated prior to March 1st, 2003 have the diverter timing triggered on the trailing edge of the coin versus the leading edge of the coin. The new method allows about 12ms more time to move the diverter flapper if it is a slow mechanism, or if it is mounted with little space directly under the coin acceptor.

NRI Emulation For Identification

It is often required that the host machine maintain the count of coins going to the hopper and the count of coins going to the drop. If there is more than one type of coin being accepted, not only will we want to always send one to the drop vault, but there may different values for the coins. In any case, the host machine must be able to separately identify the coins. Although IDX Xeptors support a multi-pulse output stream for coins to support coins having different values, when coins are fast fed these pulses can run together. Even though the total credit amount may be correct, it will likely be impossible to know what combination of coins created this credit pulse stream. If the host machine counts credit pulses from its own credit optics beneath the coin acceptor, there will only be a single pulse per coin delivered to the machine, thus invalidating this method altogether.

IDX Xeptors also support as so called NRI Emulation mode in which a separate code can be output for each coin. **Currently the X-10 and X-50 require the XNRI-V3.0t processor chip.** Version 4.0 firmware used in the X20 and X-60 Xeptors (and in the future for the X-10 Xeptor) may be set to operate in the NRI mode by setting Bit-1 of the SysConfig Byte (see product manual). When this bit is set, the Coin Value parameter (normally used to set the number of output pulses for the coin) is used to determine the output code. Although this is primarily intended for use with the PPNRI-3 and PPNRI-6 personality plugs for compatibility with the NRI 10pin IDC connector, it may also be used with the PP46 and PP62, both of which bring out all three of the /Tilt, /Credit and /Sense signals which are re-assigned during NRI emulation as binary output code bits 0, 1, and 2 respectively. The PPNRI-6 outputs are exclusive "1 of N" style, whereas the PPNRI-3 outputs are of the binary code style. If three or fewer coin types are to be accepted, using Coin Values of 1, 2, and 4 will provide a separate output signal for each of the 3 coin types for the PPNRI-3, PP46 or PP62 Personality Plugs. Finally, if there is a Tilt condition, output code 7 (all three binary bits) will be issued with the same pulse width, repetitively until the condition is cleared.

Personality Plug Model:	PPNRI-6	PPNRI-3	PP46	PP62
Compatibility Connector	NRI 10pin IDC	NRI * 10pin IDC	*CC-46 Molex-6*	*CC-62 Molex-7*
Pin 1	Ground	Ground	Inhibit	Ground
Pin 2	12VDC	12VDC	/Tilt	/Sense
Pin 3	/Output5	-----	/Credit	/Tilt
Pin 4	/Output6	-----	/Sense	/Credit
Pin 5	Coin Return	-----	12 VDC	Key Pin
Pin 6	Inhibit	Inhibit	Ground	12 VDC
Pin 7	/Output1	/Output1		Inhibit
Pin 8	/Output2	/Output2		
Pin 9	/Output3	/Output3		
Pin 10	/Output4	-----		

Remember, coins signatures learned for Coin Memories 1-3 will not activate the diverter, those for Coin Memories 4-6 will activate the diverter. When going through the coin learn procedure, the output channel/code is specified by the number times the button is pressed.

Summary Check List Notes

- **Diverter Driver connection depends on path (hopper or drop) active diverter sends coin.**
- **Verify response time suitability of existing diverter mechanism with pulse generator test.**
- **The coin is moving about 70 inches per second.**
- **Timing sequence starts the coin is 2.25 inches from the bottom of the Xeptor.**
- **Set Divert_Delay for about 8ms less than highest reliable value.**
- **Set Divert_Pulse for about 8ms more than lowest reliable value.**
- **Use "P" command to set diverter timing values. Use "S" command to save to EEROM.**
- **Use NRI Emulation for output pulses on separate wires for different coins.**
- **Coin Memories 1-3 do not activate the diverter while 4-6 do activate the diverter.**